# 2013 Furbearer Program Annual Report

MISSOURI DEPARTMENT OF CONSERVATION

RESOURCE SCIENCE DIVISION

JEFF BERINGER, RESOURCE SCIENTIST
JUSTAN BLAIR, RESOURCE ASSISTANT

# TABLE OF CONTENTS

INTRODUCTION ..... 2

SECTION 1

FUR HARVEST COMPARISONS ..... 3

MISSOURI FUR AUCTION PRICES ..... 4

RACCOON POPULATION AND HARVEST TRENDS ..... 6

COYOTE POPULATION AND HARVEST TRENDS ..... 8

FOX POPULATION AND HARVEST TRENDS ..... 10

BOBCAT POPULATION AND HARVEST TRENDS ..... 13

OTTER POPULATION AND HARVEST TRENDS ..... 18

SECTION 2

FURBEARER SIGN STATION SURVEY ..... 23

ARCHER'S INDEX TO FURBEARER POPULATION ..... 27

BADGERS STATUS IN MISSOURI ..... 32

MONITORING AND DEMOGRAPHIC ASSESSMENT
OF RIVER OTTERS AND BOBCATS IN MISSOURI ..... 37

LARGE CARNIVORE INVENTORY ..... 40

MOUNTAIN LION RESPONSE TEAM ..... 42

BLACK BEAR DISTRIBUTION AND STATUS ..... 46

# INTRODUCTION

**Missouri's wild fur market** has been monitored annually since 1940, with some information dating back to 1934. Over time, MDC has witnessed tremendous fluctuations in the harvests of Missouri's primary furbearing animals as both market and social trends change. MDC monitors the fur market using mandatory fur dealer transaction records, mandatory pelt registration of bobcats (since 1980) and river otters (since 1996), and information gathered at fur auctions. Most of the information in this report is based on harvest from trappers although some species are also hunted.

The number of Fur Dealer Permits issued by the Missouri Department of Conservation peaked at 1,192 during the 1945-46 season. In 2012, MDC sold 48 Resident and 9 Non-Resident Fur Dealer Permits. The number of Resident Trapping Permits sold peaked at 13,248 in 1980-81 (permits were first required in 1953), and reached a low of 2,050 in 2000. During the 2012-13 trapping season, MDC sold 9,192 Resident and 294 Non-Resident Trapping Permits (Table 1).

Total pelts harvested reached 834,935 in 1940-41 (over 70% were opossum and skunk pelts), and again reached the second highest peak in 1979 at 634,338 when average raccoon pelt values were estimated at $27.50. The overall value of the furbearer harvest also peaked in 1979-80 at over $9 million. Pelt values declined dramatically during the late 1980s and through the mid-1990s; as a result the number of participants fell to all-time lows. Current market trends suggest that pelt values for many furbearers are regaining some strength as China's participation in the fur market increases. In addition many fashion designers are trending back to fur thus expanding the market.

In addition to harvest information, wildlife population trends are monitored using archer's indices and sign station surveys. Archer's indices are based on annual wildlife observation reports sent in by cooperating bow hunters. Sign station surveys are run each September by Conservation Department staff in 25 counties. A more detailed account of sign station surveys and archer's indices can be found in Section 2.

Also contained in Section 2 are updates and progress summaries for various furbearer-related research projects, monitoring efforts, or items of interest. These are only for informational purposes and should be considered draft reports. For more information on any of these draft reports please contact Jeff Beringer at jeff.beringer@mdc.mo.gov.

# SECTION 1:
## Missouri Furbearer Status 2012-2013

FUR HARVEST COMPARISONS

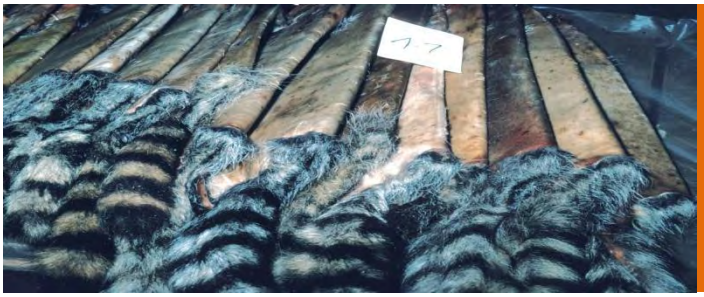
To buy and sell fur in Missouri, fur dealers must purchase a commercial permit from MDC. The permit requires fur dealers to record and submit records of all fur transactions. Data collected from fur dealers gives MDC an estimate of furbearer harvest. In addition, harvest numbers for bobcats and otters are gathered from mandatory pelt registration required by the Convention on International Trade of Endangered Species (CITES).

A combination of favorable weather, and strong fur prices resulted in high participation by hunters and trappers this past fall. MDC sold over 9,000 trapping permits, which is a 25-year high. MDC also had an all-time record harvest for bobcats with 5,059 animals harvested, a 2nd all-time otter harvest, and the highest coyote harvest in 25 years. Participation by hunters has also been increasing. Recent survey data suggest over 13,000 hunters pursued raccoons and over 25,000 hunters pursued coyotes this past year. Forecasts for 2013 suggest the strong fur market will continue and product vendors are reporting strong sales.

Table 1. Furbearer harvest and pelt prices in Missouri over the last three years.

| Species | 2012-13 | | 2011-12 | | 2010-11 | |
|---|---|---|---|---|---|---|
| | Number of pelts sold or registered* | Pelt Prices from MTA Auctions | Number of pelts sold or registered* | Pelt Prices from MTA Auctions | Number of pelts sold or registered* | Pelt Prices from MTA Auctions |
| Raccoon | 138,865 | $20.79 | 158,356 | $10.00 | 109,586 | $10.98 |
| Opossum | 7,733 | $1.25 | 12,185 | $1.23 | 9,295 | $1.70 |
| Muskrat | 15,699 | $11.79 | 23,031 | $9.49 | 20,641 | $6.21 |
| Coyote | 7,025 | $22.26 | 4,494 | $14.93 | 4,205 | $11.04 |
| Beaver | 9,302 | $21.72 | 7,572 | $13.47 | 5,464 | $9.94 |
| Mink | 1,254 | (m)$26.72 (f)$18.67 | 1,499 | (m)$18.15 (f)$10.01 | 1,085 | (m)$14.18 (f)$7.21 |
| Red Fox | 1,401 | $39.13 | 1,191 | $30.08 | 1,040 | $16.78 |
| Gray Fox | 1,066 | $34.72 | 757 | $20.26 | 709 | $18.02 |
| Striped Skunk | 442 | $3.25 | 451 | $1.80 | 383 | $1.87 |
| Badger | 80 | $0.38 | 62 | $15.63 | 59 | N/A |
| Bobcat* | 5,059 | $115.50 | 4,199 | $77.66 | 3,888 | $45.21 |
| River Otter* | 4,201 | $85.53 | 4,233 | $87.80 | 2,573 | $46.95 |
| Trapping permits sold | 9,192 | | 7,549 | | 5,618 | |

* Pelts sold (except bobcat and otter where harvest is based on CITES registration) is based on reports received from the 43 Fur Buyer Permittees.



# MISSOURI FUR AUCTION PRICES

The Missouri Trappers Association (MTA) held two fur auctions this year in Marshall, Mo. Prices are averaged from all fur sold, including green, finished and damaged (Table 2). Average pelt prices were higher this year for most species (Table 3). Otter prices fell slightly from a six year high in 2012. Badger prices fell dramatically, but as only seven pelts were sold at the auction, the quality of the pelts played a major role in determining the price.

Table 2. Range of furbearer pelt prices in Missouri during the 2012-13 trapping season.

| | 2013 Auction Summary | | | | |
|---|---|---|---|---|---|
| Species | Total Number of Pelts Sold | 09-Feb | 23-Feb | Average Prices for 2013 | Change in Price from Last season |
| Raccoon | 7,966 | $16.96 | $24.62 | $20.79 | 107.90% |
| Opossum | 515 | $1.52 | $0.98 | $1.25 | 1.63% |
| Muskrat | 1,712 | $11.00 | $12.57 | $11.79 | 24.18% |
| Coyote | 354 | $16.41 | $28.10 | $22.26 | 49.06% |
| Beaver | 1071 | $21.08 | $22.36 | $21.72 | 61.25% |
| Mink – Male | 76 | $21.37 | $26.72 | $24.05 | 32.48% |
| Mink – Female | 25 | $13.55 | $18.67 | $16.11 | 60.94% |
| Red Fox | 73 | $39.13 | N/A | $39.13 | 30.09% |
| Gray Fox | 55 | $34.72 | N/A | $34.72 | 71.37% |
| Striped Skunk | 8 | $3.25 | N/A | $3.25 | 80.56% |
| Badger | 7 | $0.50 | $0.25 | $0.38 | -97.60% |
| Bobcat | 226 | $97.57 | $133.42 | $115.50 | 48.72% |
| Otter | 410 | $80.01 | $91.04 | $85.53 | -2.59% |

Table 3. Comparison of average furbearer auction prices over the last five trapping seasons.

| Species | Average Price Per Season | | | | | 5 year average |
|---|---|---|---|---|---|---|
| | 2012-13 | 2011-12 | 2010-11 | 2009-10 | 2008-09 | |
| Raccoon | $20.79 | $10.00 | $10.98 | $12.20 | $9.77 | $12.75 |
| Opossum | $1.25 | $1.23 | $1.70 | $2.22 | $1.98 | $1.68 |
| Muskrat | $11.79 | $9.49 | $6.21 | $6.91 | $3.08 | $7.50 |
| Coyote | $22.26 | $14.93 | $11.04 | $10.95 | $8.75 | $13.59 |
| Beaver | $21.72 | $13.47 | $9.94 | $13.75 | $11.84 | $14.14 |
| Mink (male) | $24.05 | $18.15 | $14.18 | $10.67 | $7.87 | $14.98 |
| Red Fox | $39.13 | $30.08 | $16.78 | $14.82 | $13.30 | $22.82 |
| Gray Fox | $34.72 | $20.26 | $18.02 | $15.08 | $17.85 | $21.19 |
| Str. Skunk | $3.25 | $1.80 | $1.87 | $2.75 | $3.73 | $2.68 |
| Badger | $0.38 | $15.63 | N/A | $3.50 | $17.50 | $9.25 |
| Bobcat | $115.5 | $77.66 | $45.21 | $36.30 | $23.68 | $59.67 |
| Otter | $85.53 | $87.80 | $46.95 | $37.84 | $26.91 | $57.01 |

# RACCOON POPULATION AND HARVEST TRENDS

Raccoon harvest, including trapping, for the 2012-13 season was 138,865, down 12.31% from the 2011-12 season but up 26.72% from the 2010-11 season (Figure 1). Many trappers reported lower numbers of raccoons and much of the harvest was comprised of adult males. The archer observation data corroborated this observation as raccoon indices were down 35%. Drought conditions throughout Missouri may have reduced raccoon survival or caused a range shift due to dry creeks and wetlands.

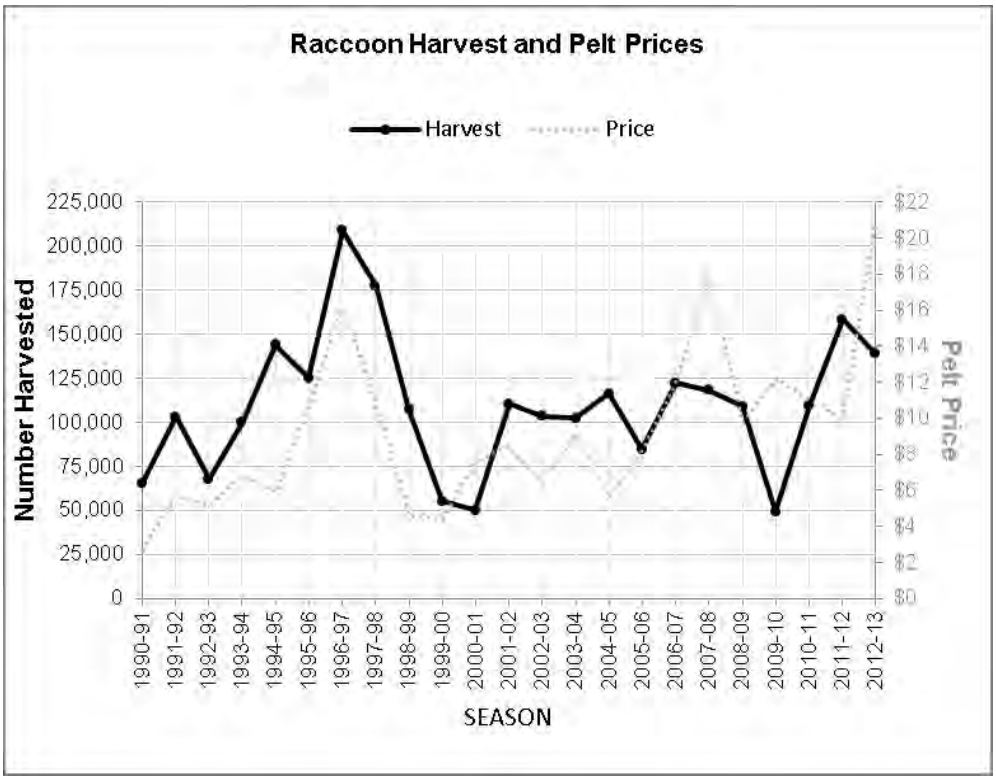



Figure 1. Comparison of raccoon harvest and pelt prices over the last 23 years.

Raccoon indices, based on observations from bowhunters, decreased about 35% to 45.8 in 2012, down from an all-time high in 2011 of 70.1(Figure 2). The presence of raccoon tracks at furbearer sign stations also fell, although slightly, to an index of 186.88 in 2012, after reaching an all-time high in 2011 with an index of 188.92. The observed declines could be a result of increased harvest pressures and/or a habitat shift from the extreme heat and drought experienced during the summer months of 2012.

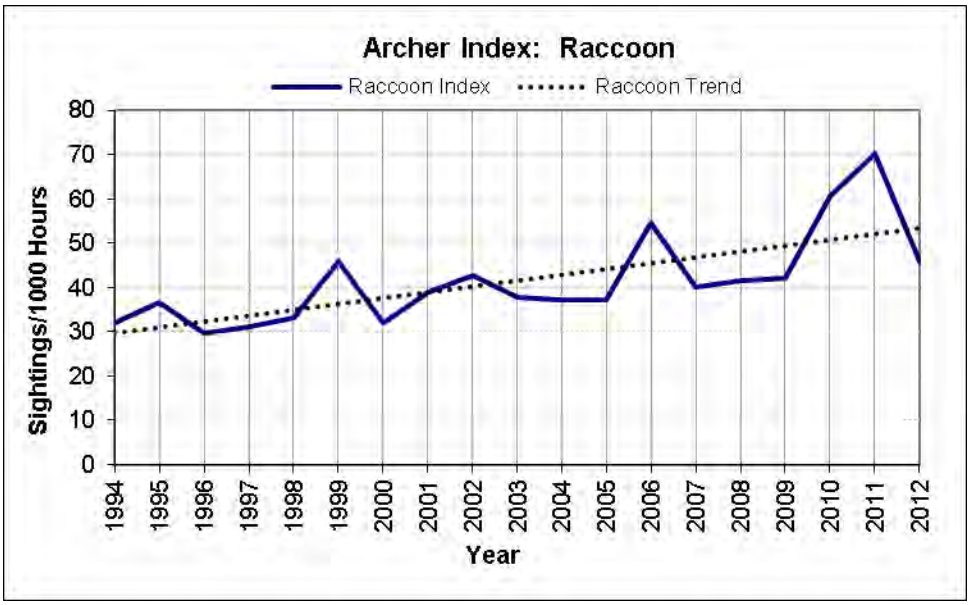



Figure 2. Raccoon population trends based on MDC bowhunter observation survey.

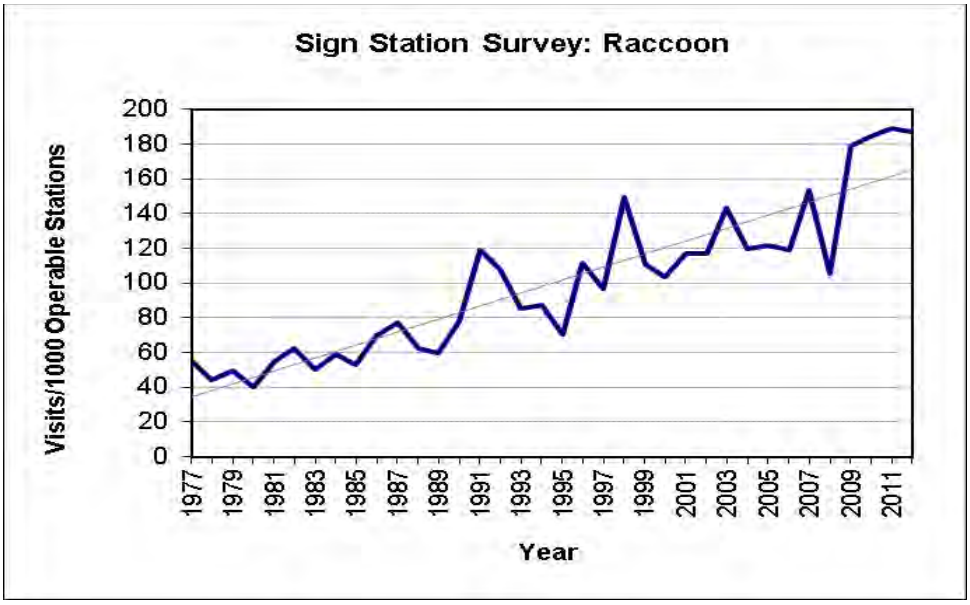



Figure 3. Raccoon population trends based on sign station surveys.

# COYOTE POPULATION AND HARVEST TRENDS

Coyote harvest during the 2012-13 season (7,025) was up 56.32% from the 2011-12 season (Figure 4) and marked a 25-year high. Weather likely affected coyote trapping as we experienced warm dry weather for much of the season. Although coyote pelt prices averaged only $22.26, many trappers still enjoy the challenge of catching coyotes. The use of cable restraints has increased coyote harvest for the fur and live markets. Trend data for coyotes suggest populations are stable but higher than those observed during the mid-1970s (Figures 5 and 6). Mange in both coyotes and red fox is reported each year but major outbreaks have not been confirmed for 2012.

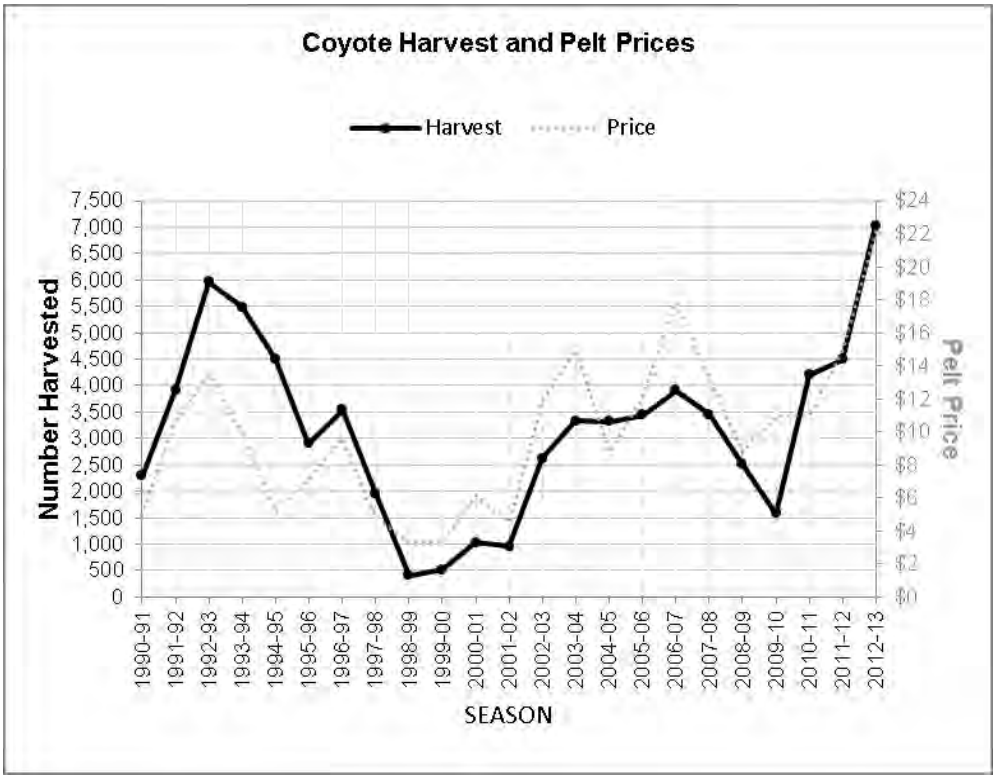



Figure 4. Comparison of coyote harvest and pelt prices over the last 23 years.

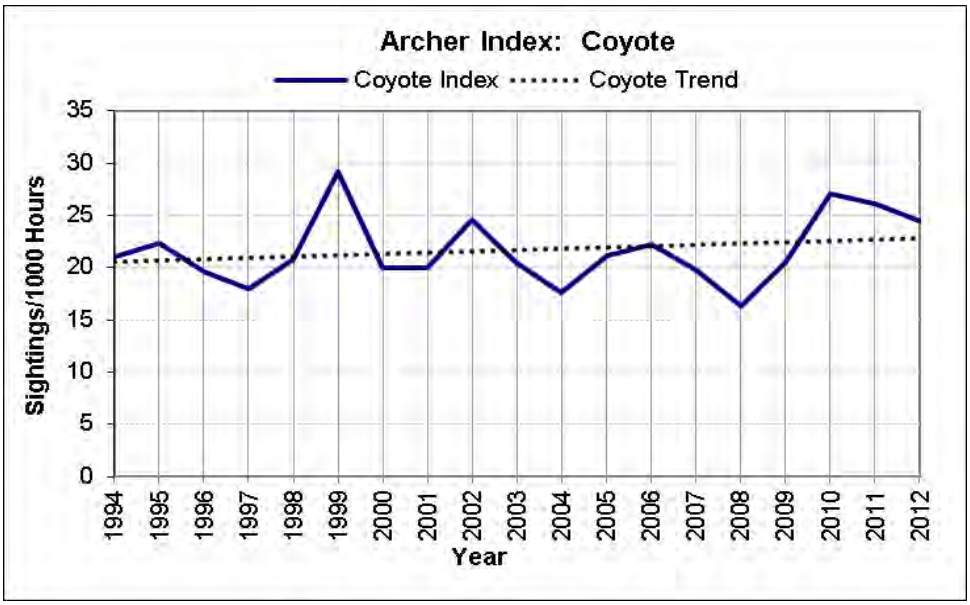



Figure 5. Coyote population trends based on MDC bowhunter observation survey.

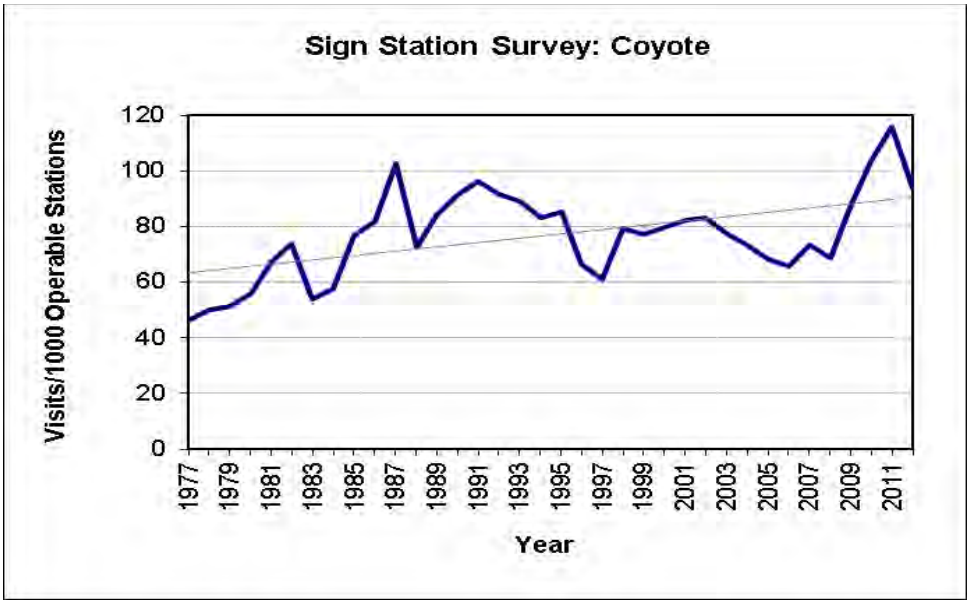



Figure 6. Coyote population trends based on sign station surveys.

# FOX POPULATION AND HARVEST TRENDS

During the 2012-13 season, red fox harvest (1,401) increased 17.63% and gray fox harvest (1,066) increased 40.82% when compared with last year's harvest (Figures 7 and 8). Fox harvest is typically a by-product of bobcat or coyote trapper effort. Because bobcat prices were high in 2012 more land trappers were active and thus fox harvest increased. From a long term perspective, both archer observations and sign station surveys suggest declines in both red and gray fox populations (Figures 9 and 10), although, 2012 archer and sign station data suggest both red and gray fox numbers increased this past year. Long term fox population declines may be the result of interspecific competition with coyotes and bobcats. Another possible reason for the gray fox decline could be the increasing population of raccoons and their associated distemper virus; gray fox seem especially vulnerable to distemper virus.

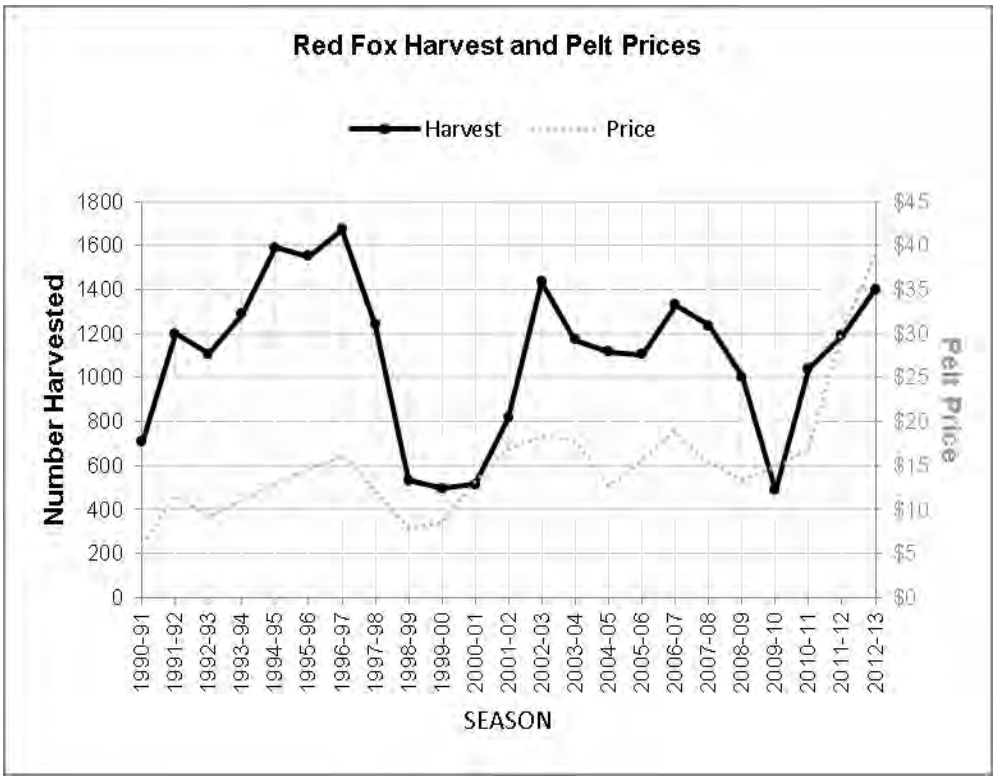



Figure 7. Comparison of red fox harvest and pelt prices over the last 23 years.

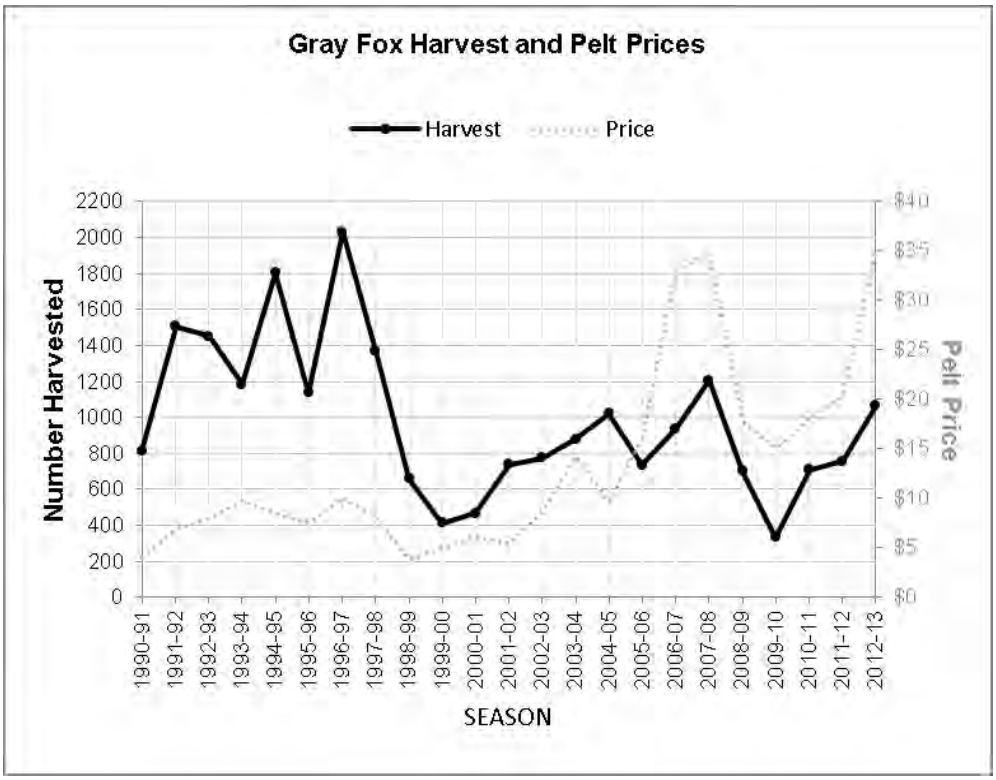



Figure 8. Comparison of gray fox harvest and pelt prices over the last 23 years.

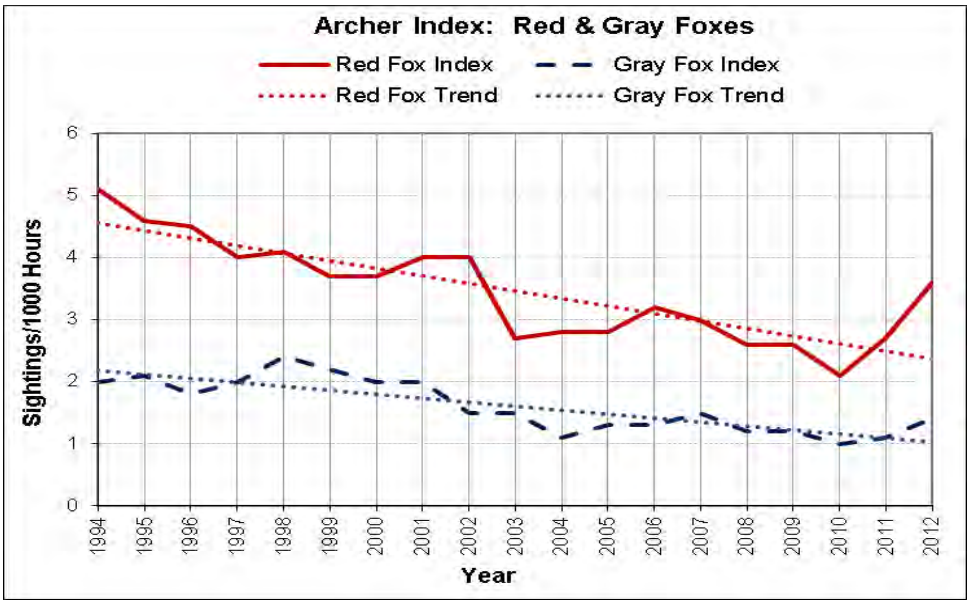



Figure 9. Fox population trends based on MDC bowhunter observation survey.

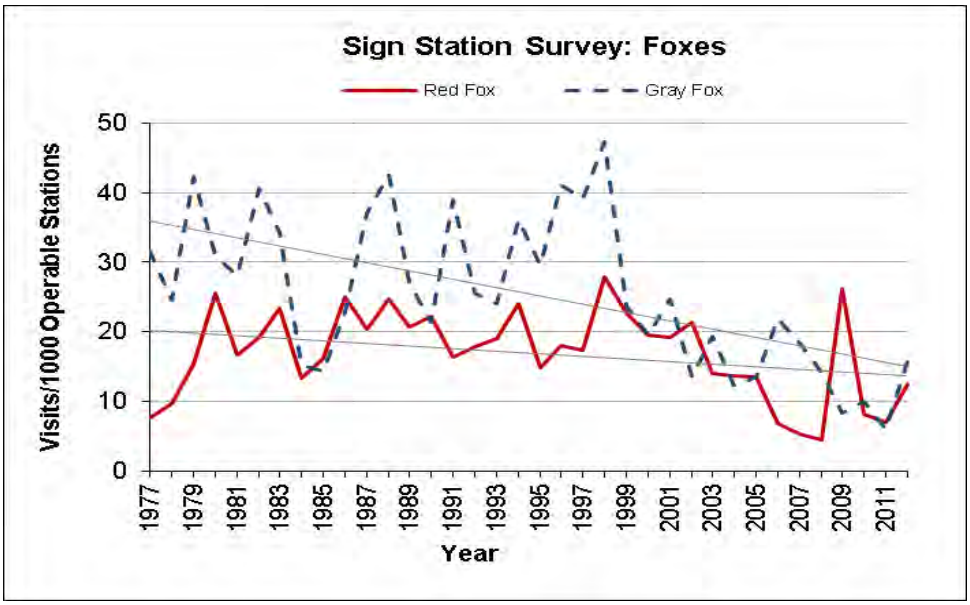



Figure 10. Fox population trends based on sign station surveys.

# BOBCAT POPULATION AND HARVEST TRENDS

Trappers and hunters are required to check and seal bobcat carcasses or green pelts at MDC offices or with Conservation Agents. The data collected are used to monitor bobcat harvest in Missouri and to comply with CITES regulations.

The statewide harvest of bobcats during 2012-13 was an all-time record, with 5,059 bobcats harvested. This is an increase of 20.48% from 2011-12, and 30.12% from 2010-11 (Figure 11) and surpasses the previous record set during the 2006-07 season by 606 individuals. Pelt prices during 2012-13 season, the all-time high, averaged $115.50. Bobcats have continued to expand across north Missouri and have now established in all suitable habitats. During 2012-13 Missouri had a significant increase in trappers and, although the mild weather may have reduced movements, the dry conditions were more favorable for land trapping.

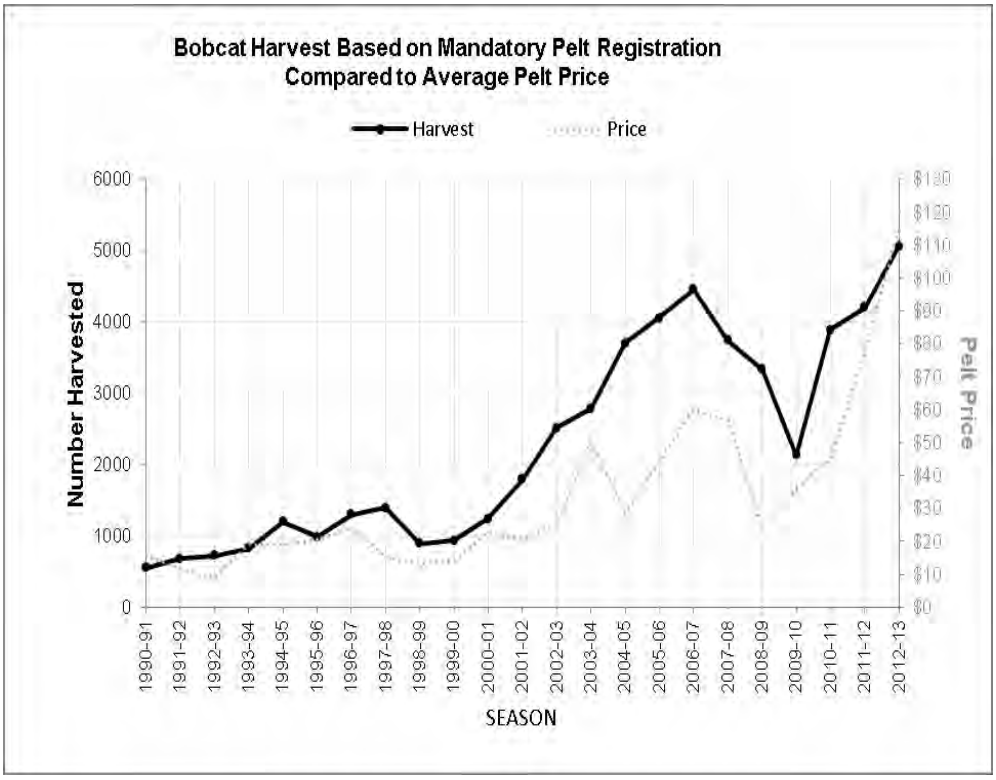



Figure 11. Bobcat harvest trends over the last 23 years compared to average pelt prices.

The number of bobcat pelts purchased by fur dealers (3,039) was significantly less than the number of bobcats checked by trappers as required by CITES (5,059). Instead of selling to fur buyers, trappers can make more money by selling carcasses to taxidermists or selling mounted bobcats on the internet. The significant drop in pelt sales to fur dealers is likely a reflection of this trend.

Archer Index data suggested an increase in bobcat sightings while sign station data suggest bobcat populations may have dipped some over the last couple years – the overall trend appears to be stable to slightly increasing (Figures 12 and 13). MDC saw no specific trend in regional harvests (Table 4, Figure 15) throughout the state. Bobcat harvest distribution suggests high harvest occurs early in the season, mostly from firearms deer hunters, and trapping harvest is later (Table 5). Pelts are most prime after December.

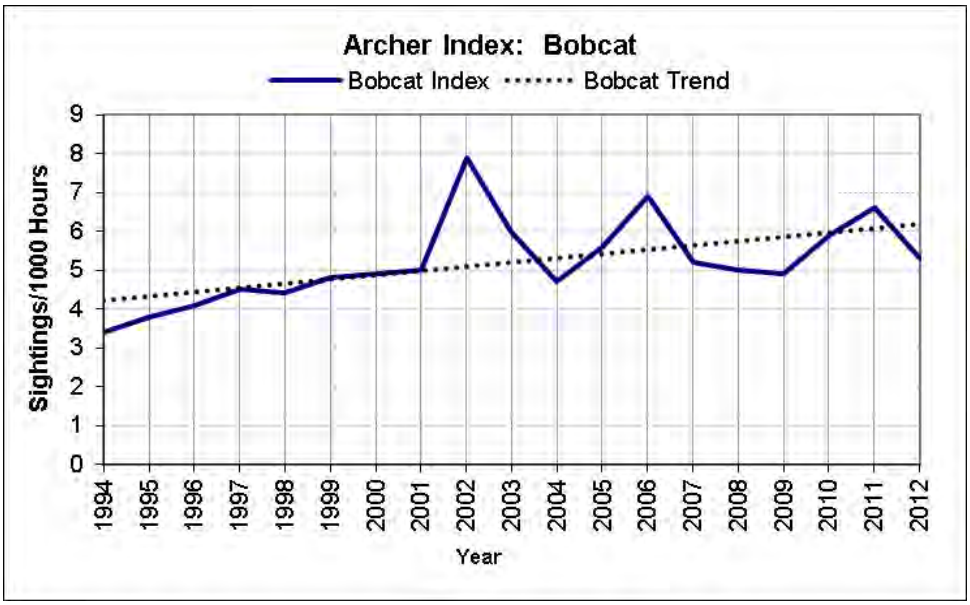



Figure 12. Bobcat population trends based on MDC bowhunter observation survey.

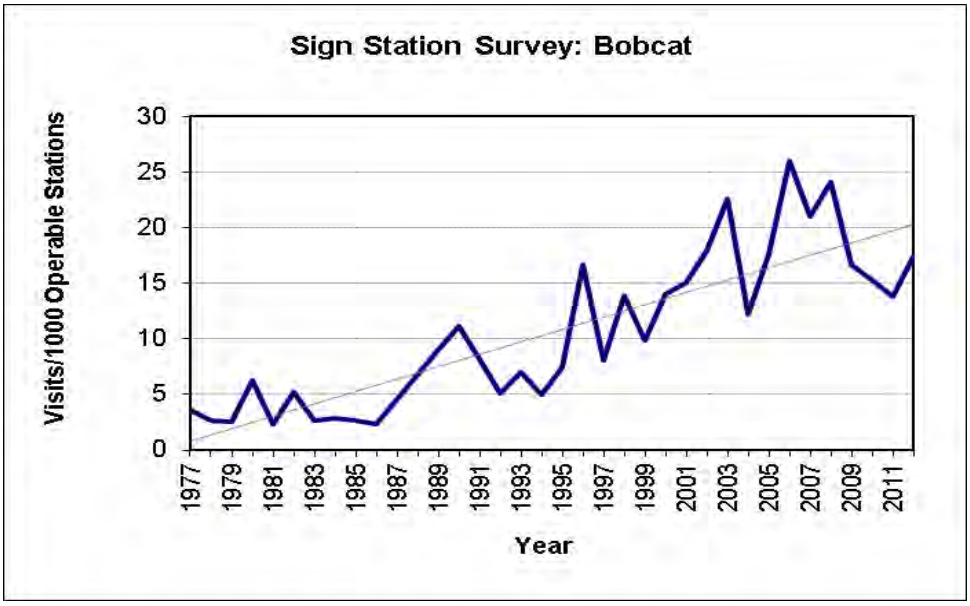



Figure 13. Bobcat population trends based on sign station surveys.

Table 4. Bobcat harvest (based on mandatory pelt registration) and pelt prices from 2003 – 2013, in Missouri, by zoological region.

| | Bobcats Harvested per Season | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Zoological Region | 2003-04 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 |
| Northwest Prairie | 347 | 410 | 470 | 493 | 358 | 341 | 150 | 342 | 391 | 421 |
| Northern Riverbreaks | 387 | 552 | 604 | 636 | 373 | 404 | 192 | 412 | 465 | 473 |
| Northeast Riverbreaks | 150 | 446 | 558 | 678 | 521 | 492 | 379 | 608 | 617 | 644 |
| Western Prairie | 605 | 624 | 616 | 763 | 572 | 446 | 235 | 542 | 694 | 807 |
| Western Ozark Border | 297 | 364 | 473 | 431 | 377 | 312 | 223 | 453 | 450 | 560 |
| Ozark Plateau | 648 | 881 | 852 | 918 | 984 | 868 | 550 | 962 | 1012 | 1486 |
| North and East Ozark Border | 233 | 291 | 289 | 372 | 316 | 307 | 243 | 369 | 395 | 439 |
| Mississippi Lowlands | 116 | 133 | 208 | 158 | 159 | 157 | 154 | 185 | 165 | 208 |
| Unknown | 0 | 0 | 1 | 4 | 46 | 6 | 2 | 0 | 10 | 21 |
| TOTAL | 2,783 | 3,701 | 4,061 | 4,453 | 3,706 | 3,333 | 2,128 | 3,888 | 4,199 | 5,059 |
| Bobcat Pelt Prices | $50.15 | $28.50 | $44.53 | $59.78 | $56.93 | $23.68 | $36.30 | $45.21 | $77.66 | $115.50 |

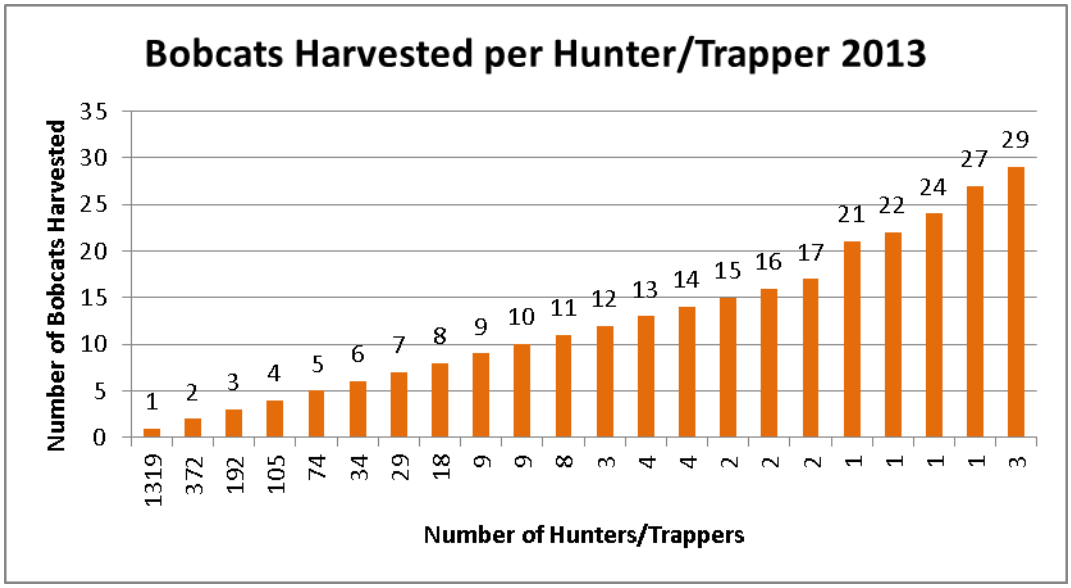



Figure 14. Number of bobcats harvested by individual hunter/trappers.

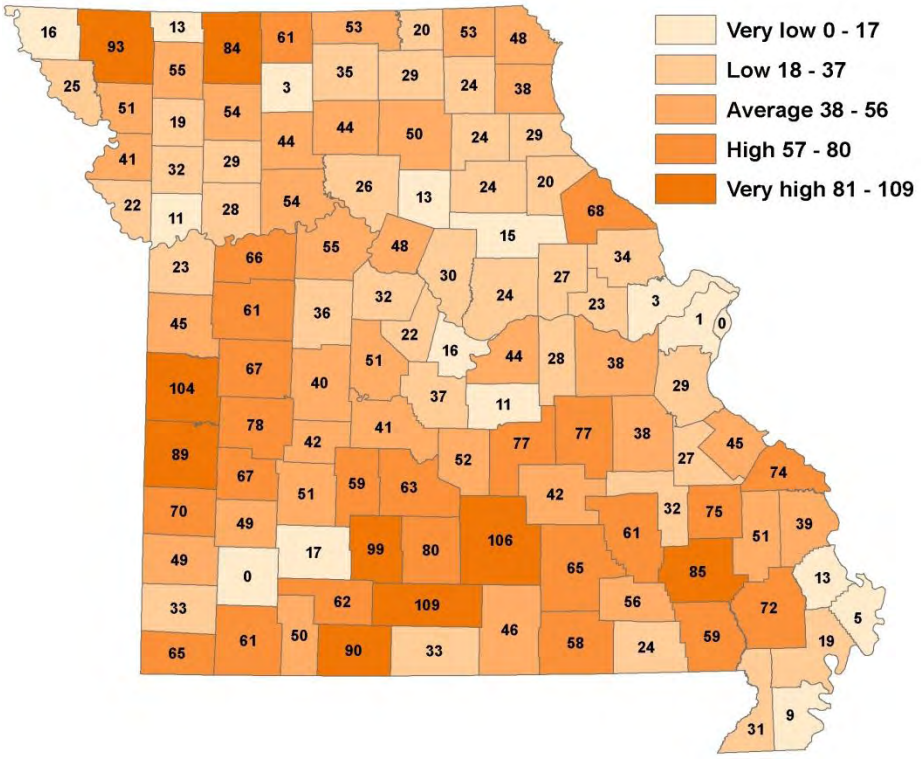



Figure 15. Bobcat harvest by county.

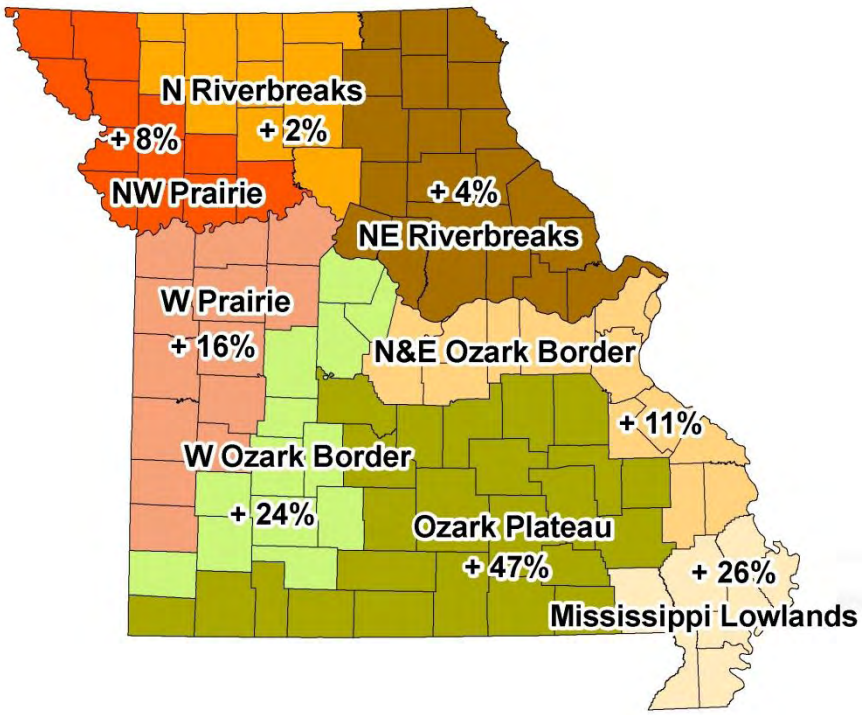



Figure 16. Comparison of bobcat harvest by Zoological region between the 2011-12 and 2012-13

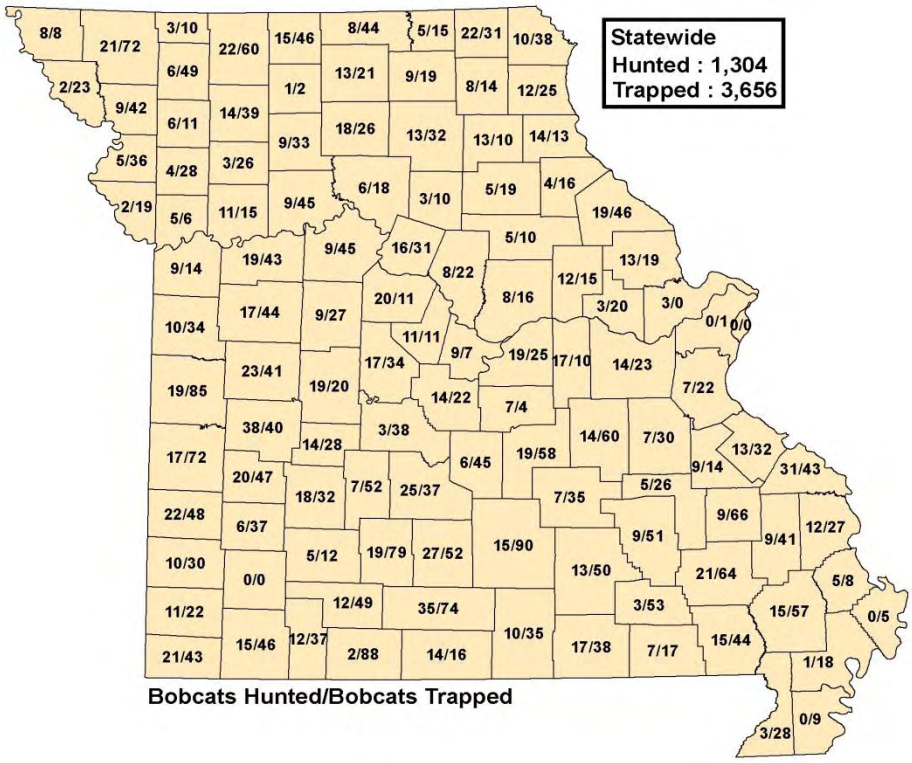



Figure 17. Comparison of hunted vs. trapped bobcats per county.

# OTTER POPULATION AND HARVEST TRENDS

Trappers are required to check and seal river otter carcasses or green hides at MDC offices or with Conservation Agents. The data collected are used to monitor statewide and regional otter harvest in Missouri and to comply with CITES regulations.

The 2012-13 season resulted in a harvest of 4,201 animals. This is down <1% from the record setting season last year, and up 63.27% from the 2010-2011 season. Otter pelt prices remained relatively constant, declining just 2.5% from last year. The stable water conditions and pelt price are likely the reasons for increased harvest (Figure 18). Harvest date for otter and bobcat are available as a result of CITES tagging. Both species have a relatively long harvest season (Table 5).

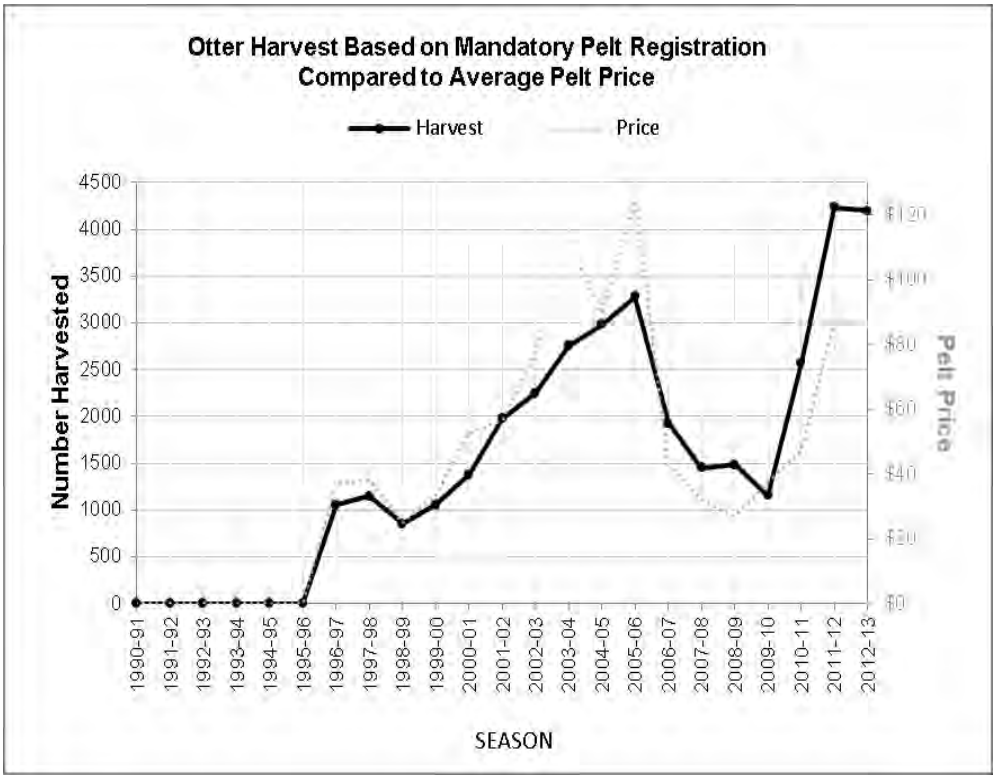



Figure 18. Otter harvest and pelt prices from 1990 – 2013.

Table 5. Bobcat and otter harvest during each week of the 2012-13 season.

| Week of Season | Dates | Number of Bobcats Harvested | Number of Otters Harvested |
|---|---|---|---|
| --- | Before Nov. 15 | 11 | 4 |
| 1 | Nov.15 – 17 | 220 | 119 |
| 2 | Nov. 18 – 24 | 427 | 354 |
| 3 | Nov. 25 – Dec. 1 | 496 | 442 |
| 4 | Dec. 2 – 8 | 385 | 463 |
| 5 | Dec. 9 – 15 | 476 | 367 |
| 6 | Dec. 16 – 22 | 416 | 348 |
| 7 | Dec. 23 – 29 | 523 | 314 |
| 8 | Dec. 30 – Jan 5 | 527 | 315 |
| 9 | Jan. 6 –12 | 488 | 280 |
| 10 | Jan. 13 – 19 | 414 | 269 |
| 11 | Jan. 20 – 26 | 426 | 209 |
| 12 | Jan. 27 – Feb 2 | 184 | 191 |
| 13 | Feb 3 – 9 | ---season closed--- | 152 |
| 14 | Feb. 10 – 16 | ---season closed--- | 184 |
| --- | Feb 17-20 | ---season closed--- | 129 |
| --- | Unknown date | 66 | 61 |
| | TOTAL | 5,052 | 4,201 |

Although most otter harvest occurs during December and January (Table 5), a longer season does facilitate targeted harvests. From a county basis otter harvest was highest in Chariton, Pike and Linn counties with harvests of 242, 98 and 98 respectively (Figure 19). Other high harvest counties were in the west-central and north-central regions of Missouri.

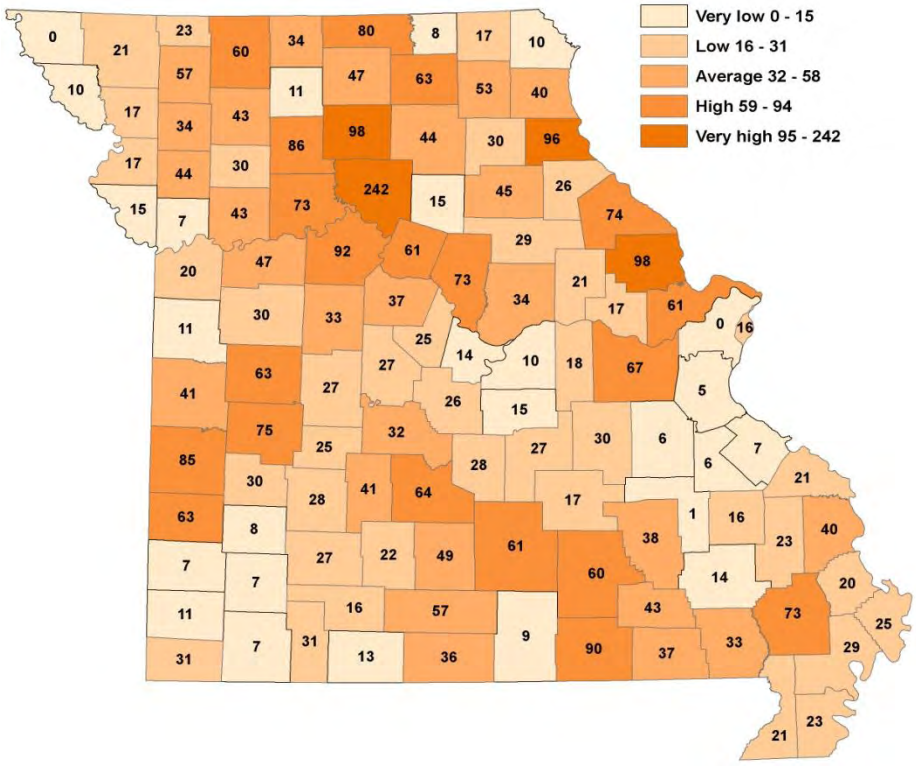



Figure 19. The number of otters harvested by county during the 2012-13 season.

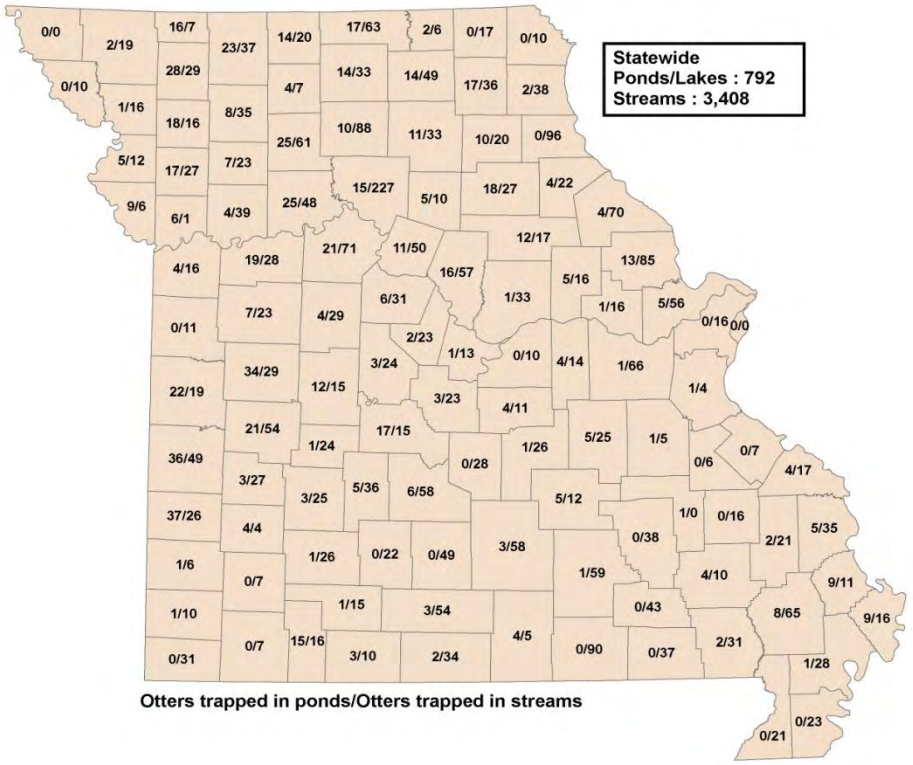



Figure 20. Comparison of otters trapped in ponds vs. streams.

Otter harvest during the 2012-13 season was highest in the Missouri River, Osage River and Grand River watersheds (Figure 21, Table 6). Over 26% (1,126) of total otters harvested were in these three watersheds. Other watersheds with high harvest included the Salt, Gasconade and Chariton.

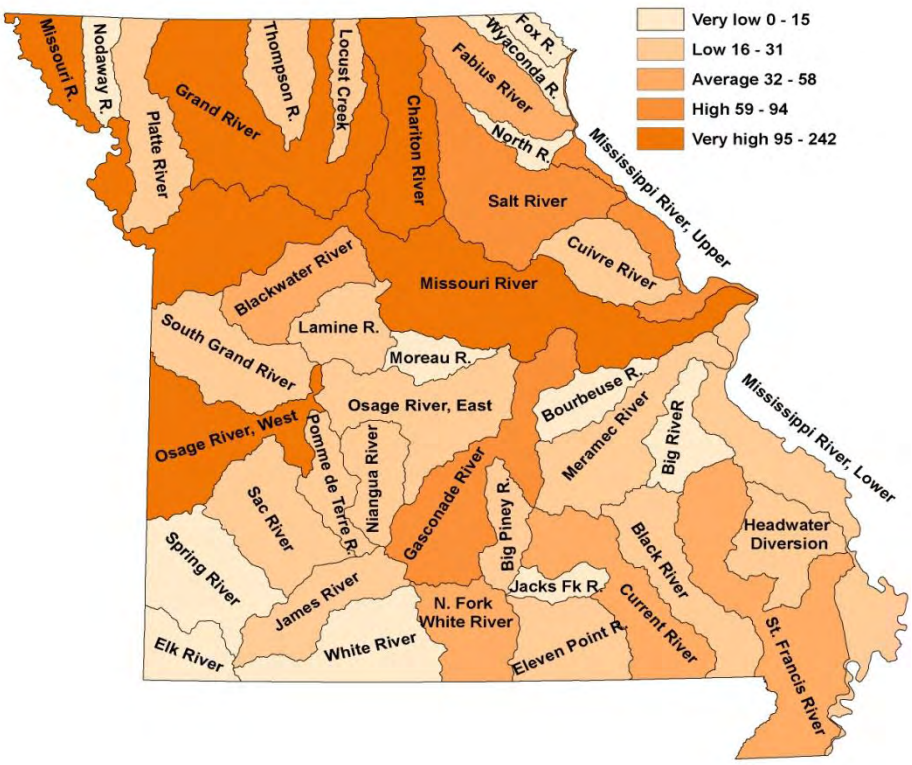



Figure 21. Otter harvest distribution among watersheds during the 2012-13 trapping season.

Table 6. Otter harvest distribution among watersheds during the 2012-13 trapping season.

| Watershed | Number Harvested | Percent of Harvest |
|---|---|---|
| Big Piney River | 50 | 1.19% |
| Big River | 1 | 0.02% |
| Black River | 79 | 1.88% |
| Blackwater River | 98 | 2.33% |
| Bourbeuse River | 26 | 0.62% |
| Chariton River | 224 | 5.33% |
| Cuivre River | 93 | 2.21% |
| Current River | 123 | 2.93% |
| Eleven Point River | 93 | 2.21% |
| Elk River | 23 | 0.55% |
| Fabius River | 109 | 2.59% |
| Fox River | 10 | 0.24% |
| Gasconade River | 186 | 4.43% |
| Grand River | 485 | 11.54% |
| Headwater Diversion | 67 | 1.59% |
| Jacks Fork River | 18 | 0.43% |
| James River | 48 | 1.14% |
| Lamine River | 71 | 1.69% |
| Locust Creek | 48 | 1.14% |
| Meramec River | 67 | 1.59% |
| Mississippi R. (lower) | 81 | 1.93% |
| Mississippi R. (upper) | 196 | 4.67% |
| Missouri River | 425 | 10.12% |
| Moreau River | 33 | 0.79% |
| N. Fork White River | 111 | 2.64% |
| Niangua River | 59 | 1.40% |
| Nodaway River | 12 | 0.29% |
| North River | 20 | 0.48% |
| Osage River East | 62 | 1.48% |
| Osage River West | 216 | 5.14% |
| Platte River | 69 | 1.64% |
| Pomme de Terre River | 68 | 1.62% |
| S. Grand River | 83 | 1.98% |
| Sac River | 75 | 1.79% |
| Salt River | 165 | 3.93% |
| Spring River | 21 | 0.50% |
| St. Francis River | 134 | 3.19% |
| Thompson River | 44 | 1.05% |
| White River | 15 | 0.36% |
| Wyaconda River | 0 | 0.00% |
| Unknown | 393 | 9.35% |
| TOTAL HARVEST | 4201 | 100% |

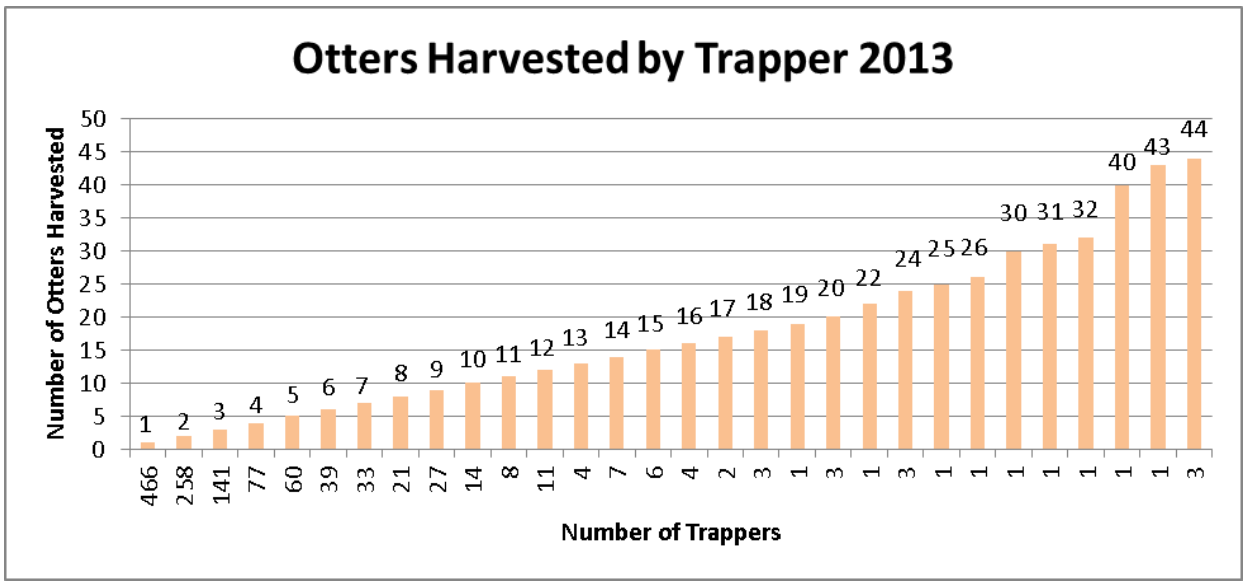



Figure 22. Number of otters harvested by individual trappers.

# SECTION 2:
## Research projects and monitoring efforts

## FURBEARER SIGN STATION SURVEY

SUMMARY OF 2012 FURBEARER SIGN STATION SURVEY

**Background**

The furbearer sign station survey occurs annually each September. The survey dates back to 1977 and gathers furbearer population trend information across the state. Currently there are 25 routes, each in a different county. Each route is broken into five segments with 10 sign stations each, for a total of 50 sign stations per route. Sign stations are 36-inch diameter circles of sifted soil, set up every 0.3 miles along shoulders of gravel roads. In the middle of each station is a scent disc infused with a fatty acid scent attractant. Stations are set up in a day and checked the next day for presence of animal tracks.

When checking the stations, observers note whether or not stations are operable. If a station has been destroyed by a road grader or other vehicle, the station is deemed inoperable and not included in index calculations. If a station is operable, it is included in the calculation of indices regardless of the presence of tracks. Observers identify any tracks within the station but do not count the number of animals of any species visiting a station.

**Results**

In 2012, 25 of 25 routes (Figure 23) were completed with a total of 1204 operable stations out of a possible 1250. A breakdown of operable stations per Zoological region is shown in Table 7. Inoperable stations were due to tire tracks and road graders.

Table 7. Summary of operable and inoperable sign stations in 2012 by Zoological region.

| Zoological region | Number of routes completed | Number of operable stations | Number of inoperable stations |
|---|---|---|---|
| Northwest Prairie | 2 | 95 | 5 |
| Northern Riverbreaks | 3 | 148 | 2 |
| Northeast Riverbreaks | 4 | 193 | 7 |
| Western Prairie | 3 | 142 | 8 |
| Western Ozark Border | 3 | 143 | 7 |
| Ozark Plateau | 6 | 290 | 10 |
| North & East Ozark Border | 3 | 143 | 7 |
| Mississippi Lowlands | 1 | 50 | 0 |
| TOTAL | 25 | 1204 | 46 |

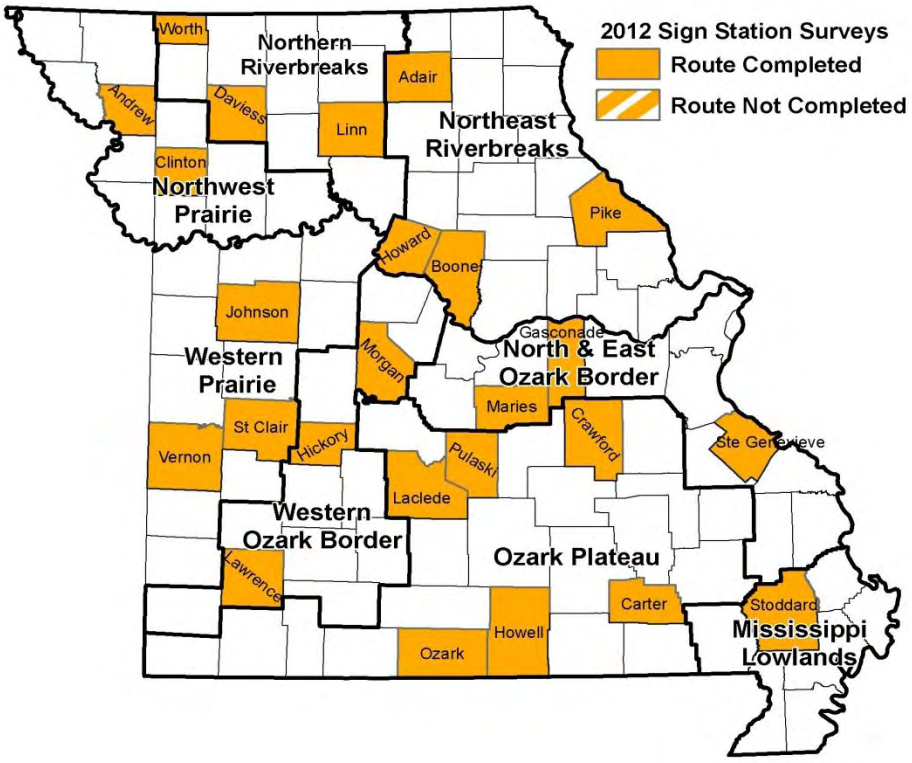



Figure 23. Map of Missouri showing counties with sign station routes within their respective Zoological region.

The most common furbearer species to visit sign stations include raccoon, opossum and coyote (Figure 24). Less common visitors include fox, mink and weasel. Birds such as sparrows, turkeys and quail are also attracted to the freshly sifted soil of the sign stations.

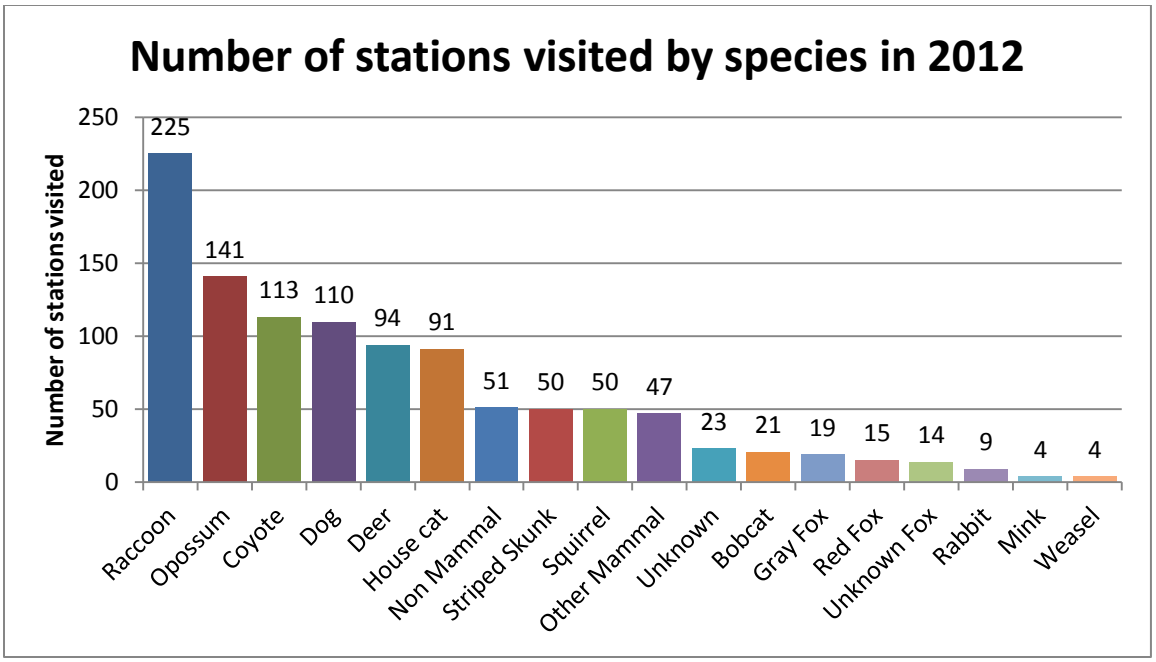



Figure 24. The number of stations visited by mammal species (including non-furbearers) out of 1204 operable stations in the 2012 survey.

Figures 25 through 28 show furbearer population trends based on the Furbearer Sign Station Survey, 1977-2012. Overall, trends indicate that most furbearer species have steady to slightly increasing populations. A slight downward trend is indicated for red and gray fox populations, which is also reflected in bowhunter observations and harvest records.

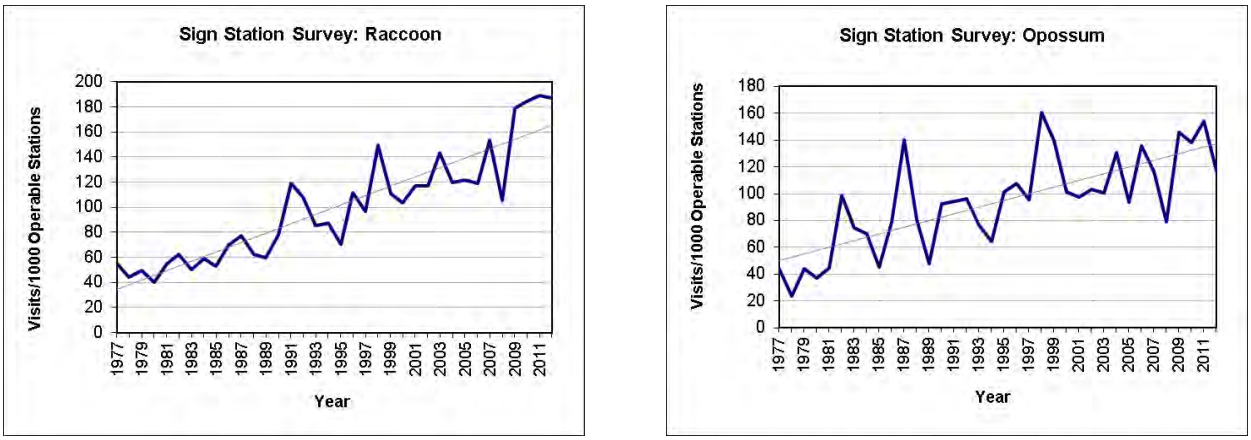



Figure 25. Raccoon and opossum population trends based on annual furbearer sign station survey.

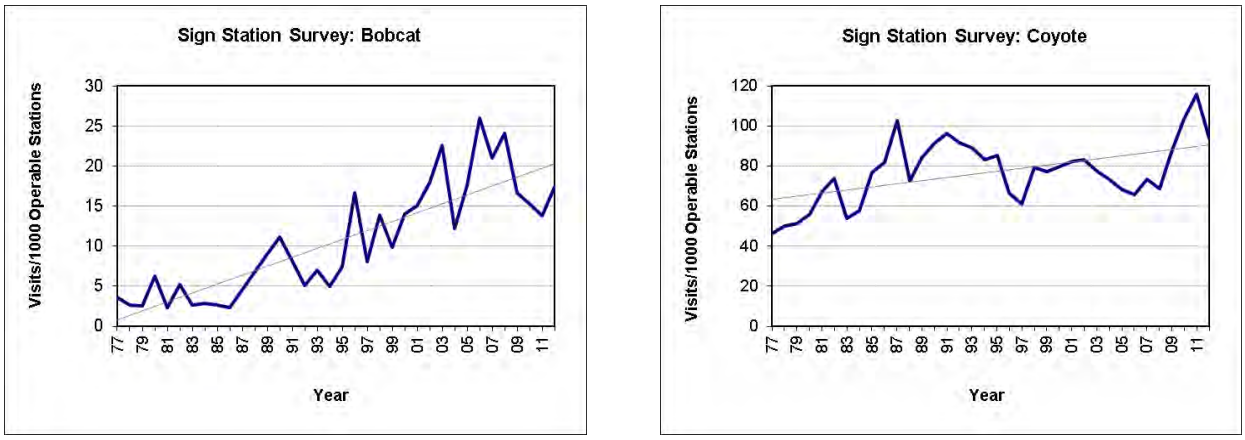



Figure 26. Bobcat and coyote population trends based on annual furbearer sign station survey.

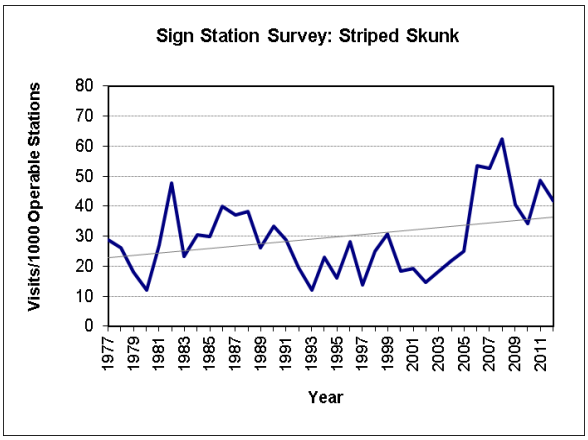



Figure 27. Skunk population trend based on annual furbearer sign station survey.

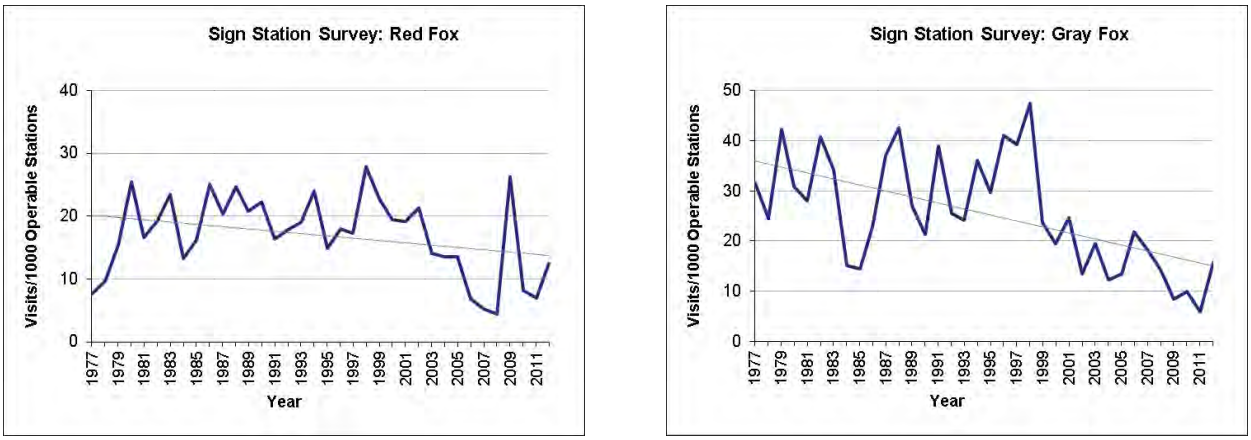



Figure 28. Red and gray fox population trends based on annual furbearer sign station survey.

# ARCHER'S INDEX TO FURBEARER POPULATIONS

MONITORING FURBEARER TRENDS USING DATA GATHERED FROM COOPERATOR BOWHUNTERS

Introduction

For 30 consecutive years (1983-2012), MDC has conducted annual surveys of wildlife populations via the archer's diary survey. Each fall, several thousand archery deer and turkey hunters keep daily observation records for furbearers, other small game animals, deer and turkeys. Archers volunteer through post-season surveys, articles in the *Missouri Conservationist* magazine, and during sign-ups at bowhunter club meetings and other outdoor events. Archery hunters are asked to record the number of hours hunted, during both morning and evening hunts, and to use a standardized daily diary to record hours and sightings of wildlife. MDC uses the number of sightings of each species divided by the total number of hours hunted statewide to calculate a sighting rate, and this is then expressed as the number of sightings per 1,000 hunter hours to calculate population indices.

Wildlife population indices calculated from archer's diaries are useful trend indicators for terrestrial wildlife such as, coyotes, raccoons, foxes, bobcats, squirrels, white-tailed deer, and turkeys. Hunters are well distributed statewide, with volunteers in 113 of the 114 counties during most years. Hunters averaged 52,930 hours in the stand over the last 30 years, and they ranged from a low of 30,990 in 1985 and a high of 84,497 in 1988 (Table 8).

Table 8. Hunter hours and furbearer population indices based on archer's diaries, 1983-2012.

| Years | Hunter Hours | Coyote | Red Fox | Gray Fox | Bobcat | Raccoon | Opossum | Striped Skunk | Mink | Beaver | Muskrat | Weasel | Badger | Otter | Black Bear |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1983 | 55,374 | 20.0 | 6.5 | 5.1 | 1.7 | 23.8 | 12.6 | 5.0 | 0.7 | 0.3 | 0.5 | 0.1 | 0.1 | 0.0 | 0.0 |
| 1984 | 32,746 | 18.8 | 6.8 | 3.1 | 1.2 | 16.9 | 6.4 | 3.5 | 0.3 | 0.3 | 0.1 | 0.0 | 0.1 | 0.0 | 0.0 |
| 1985 | 30,990 | 20.1 | 5.3 | 2.8 | 1.5 | 15.4 | 8.6 | 4.2 | 0.5 | 0.4 | 0.4 | 0.1 | 0.1 | 0.1 | 0.0 |
| 1986 | 51,727 | 23.5 | 5.7 | 2.8 | 1.5 | 15.3 | 6.9 | 3.5 | 0.3 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 1987 | 57,457 | 23.5 | 4.5 | 2.5 | 2.0 | 23.3 | 10.1 | 3.0 | 0.3 | 0.7 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 |
| 1988 | 84,497 | 22.4 | 4.7 | 2.4 | 1.7 | 16.7 | 4.8 | 2.7 | 0.3 | 0.6 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 |
| 1989 | 72,992 | 21.1 | 5.1 | 2.4 | 1.8 | 19.6 | 5.6 | 3.5 | 0.1 | 0.6 | 0.1 | 0.0 | 0.2 | 0.1 | 0.0 |
| 1990 | 72,227 | 23.6 | 4.9 | 2.3 | 2.9 | 24.0 | 7.2 | 3.5 | 0.2 | 0.4 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 |
| 1991 | 64,434 | 26.1 | 4.7 | 3.0 | 3.3 | 30.5 | 11.7 | 4.0 | 0.3 | 0.3 | 0.1 | 0.0 | 0.1 | 0.0 | 0.1 |
| 1992 | 64,452 | 22.5 | 4.7 | 2.3 | 2.9 | 24.3 | 8.9 | 2.8 | 0.6 | 0.7 | 0.1 | 0.0 | 0.1 | 0.3 | 0.0 |
| 1993 | 53,857 | 19.7 | 4.2 | 2.1 | 3.2 | 28.1 | 7.7 | 3.7 | 0.2 | 0.5 | 0.2 | 0.0 | 0.1 | 0.3 | 0.0 |
| 1994 | 49,102 | 21.0 | 5.1 | 2.0 | 3.4 | 32.0 | 7.6 | 3.2 | 0.1 | 0.5 | 0.2 | 0.0 | 0.2 | 0.2 | 0.0 |
| 1995 | 66,106 | 22.3 | 4.6 | 2.1 | 3.8 | 36.5 | 9.6 | 3.6 | 0.1 | 0.3 | 0.1 | 0.0 | 0.1 | 0.3 | 0.1 |
| 1996 | 60,077 | 19.6 | 4.5 | 1.8 | 4.1 | 29.7 | 6.6 | 2.7 | 0.0 | 0.3 | 0.0 | 0.0 | 0.1 | 0.5 | 0.0 |
| 1997 | 47,816 | 18.0 | 4.0 | 2.0 | 4.5 | 31.2 | 7.4 | 2.7 | 0.1 | 0.4 | 0.0 | 0.0 | 0.1 | 0.6 | 0.0 |
| 1998 | 43,152 | 20.8 | 4.1 | 2.4 | 4.4 | 33.0 | 10.6 | 4.2 | 0.1 | 0.3 | 0.1 | 0.0 | 0.2 | 0.3 | 0.1 |
| 1999 | 44,012 | 29.2 | 3.7 | 2.2 | 4.8 | 45.9 | 12.5 | 4.0 | 0.2 | 0.3 | 0.1 | - | 0.1 | 0.5 | - |

| YEAR | Hunter Hours | Coyote | Red Fox | Gray Fox | Bobcat | Raccoon | Opossum | Striped Skunk | Mink | Beaver | Muskrat | Weasel | Badger | Otter | Black Bear |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2000 | 50,795 | 20.0 | 3.7 | 2.0 | 4.9 | 32.1 | 8.1 | 3.3 | 0.0 | 0.2 | 0.0 | 0.0 | 0.1 | 0.3 | 0.0 |
| 2001 | 47,023 | 19.5 | 3.6 | 2.1 | 5.2 | 38.7 | 8.2 | 4.7 | 0.1 | 0.4 | 0.0 | 0.0 | 0.1 | 0.3 | 0.0 |
| 2002 | 42,826 | 24.6 | 3.8 | 1.5 | 7.9 | 42.6 | 14.4 | 5.6 | 0.3 | 0.1 | 0.0 | 0.0 | 0.1 | 0.8 | 0.1 |
| 2003 | 39,964 | 20.5 | 2.7 | 1.5 | 6.0 | 37.9 | 7.2 | 3.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 | 0.6 | 0.0 |
| 2004 | 35,071 | 17.6 | 2.8 | 1.1 | 4.7 | 37.3 | 7.9 | 2.6 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 1.2 | 0.0 |
| 2005 | 68,440 | 21.2 | 2.8 | 1.3 | 5.6 | 37.3 | 8.5 | 2.5 | 0.1 | 0.3 | 0.0 | 0.0 | 0.1 | 0.5 | 0.0 |
| 2006 | 60,040 | 22.2 | 3.2 | 1.3 | 6.9 | 54.4 | 14.4 | 3.8 | 0.3 | 0.2 | 0.0 | 0.0 | 0.1 | 0.5 | 0.0 |
| 2007 | 50,390 | 19.8 | 3.0 | 1.5 | 5.2 | 40.0 | 9.4 | 4.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 | 0.4 | 0.0 |
| 2008 | 44,471 | 16.3 | 2.6 | 1.2 | 5.0 | 41.5 | 7.8 | 3.7 | 0.1 | 0.1 | 0.1 | 0.0 | 0.4 | 0.3 | 0.0 |
| 2009 | 44,919 | 20.6 | 2.6 | 1.2 | 4.9 | 42.0 | 12.4 | 4.4 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 1.2 | 0.1 |
| 2010 | 42,907 | 27.1 | 2.1 | 1.0 | 5.9 | 60.6 | 12.9 | 3.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.2 | 0.7 | 0.0 |
| 2011 | 41,370 | 26.1 | 2.7 | 1.1 | 6.6 | 70.1 | 16.6 | 4.6 | 0.2 | 0.1 | 0.1 | 0.0 | 0.2 | 0.9 | 0.1 |
| 2012 | 68,674 | 24.4 | 3.6 | 1.4 | 5.3 | 45.8 | 7.1 | 5.6 | 0.1 | 0.1 | 0.0 | 0.0 | 0.3 | 1.1 | 0.0 |

Line graph representations of archer indices for several furbearer species are shown in Figure 29. Based on these indices, raccoon, bobcat and opossum populations show a steady rise. Striped skunk and coyote populations are holding relatively steady, while graphs indicate a downward trend for red and gray fox populations. Wildlife population indices are also depicted by county (Table 9).

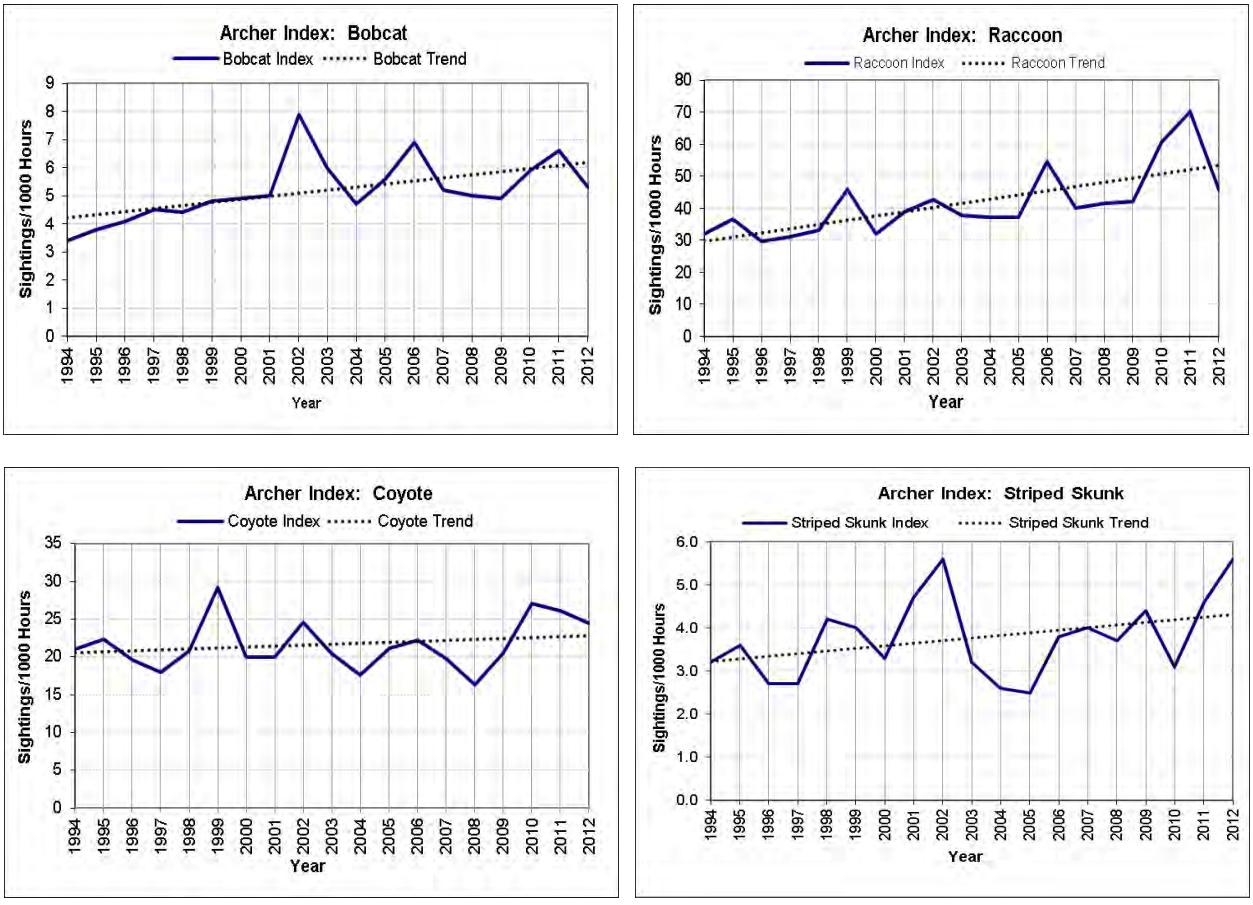
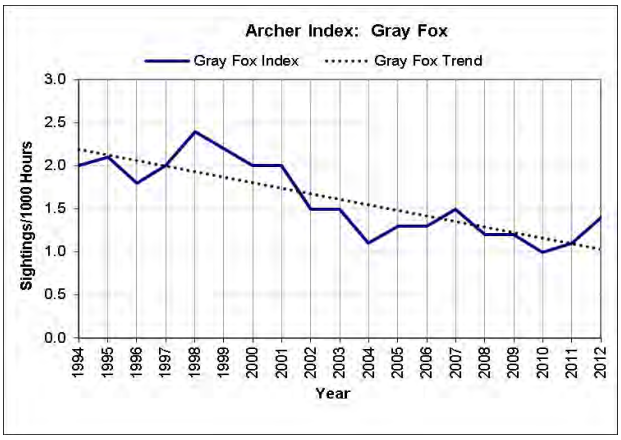



Figure 29. Population trends of some furbearing species based on archer observations.



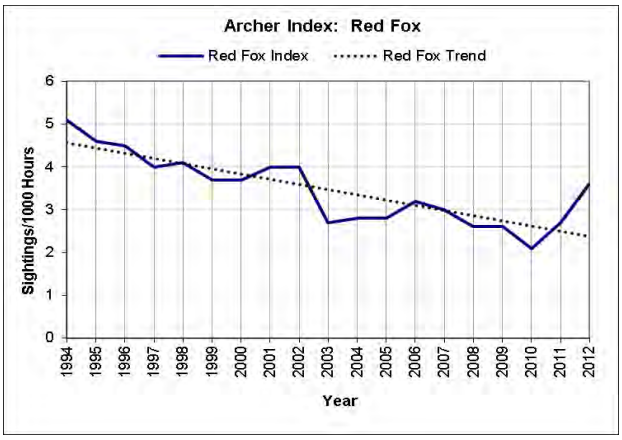




Figure 29 (continued). Population trends of some furbearing species based on archer indices.

Table 9. County wildlife Indices for 2012 based on sightings by cooperator archery hunters (sightings/1,000 hours).

| County | Coyote | Deer | Turkey | Raccoon | Opossum | Red Fox | Gray Fox | Bobcat | Badger | Bear |
|---|---|---|---|---|---|---|---|---|---|---|
| Adair | 30 | 1837 | 540 | 52 | 9 | 3 | 0 | 5 | 0 | 0 |
| Andrew | 68 | 1183 | 769 | 151 | 40 | 4 | 0 | 12 | 0 | 0 |
| Atchison | 47 | 933 | 490 | 107 | 0 | 0 | 0 | 13 | 0 | 0 |
| Audrain | 11 | 902 | 664 | 68 | 0 | 0 | 0 | 2 | 0 | 0 |
| Barry | 16 | 728 | 223 | 41 | 12 | 4 | 0 | 9 | 0 | 0 |
| Barton | 84 | 1464 | 888 | 52 | 17 | 0 | 0 | 17 | 0 | 0 |
| Bates | 115 | 1138 | 624 | 95 | 14 | 0 | 0 | 0 | 0 | 0 |
| Benton | 23 | 797 | 464 | 23 | 1 | 1 | 2 | 23 | 1 | 0 |
| Bollinger | 20 | 650 | 417 | 39 | 5 | 0 | 0 | 2 | 0 | 0 |
| Boone | 14 | 1224 | 314 | 39 | 3 | 3 | 2 | 4 | 0 | 0 |
| Buchanan | 107 | 655 | 351 | 60 | 25 | 6 | 0 | 6 | 0 | 0 |
| Butler | 0 | 412 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 |
| Caldwell | 30 | 973 | 683 | 82 | 9 | 3 | 0 | 6 | 0 | 0 |
| Callaway | 22 | 762 | 506 | 39 | 5 | 12 | 2 | 2 | 1 | 0 |
| Camden | 18 | 1052 | 572 | 15 | 2 | 5 | 0 | 15 | 0 | 0 |
| Cape Girardeau | 14 | 656 | 324 | 38 | 2 | 2 | 0 | 4 | 0 | 0 |
| Carroll | 26 | 1155 | 503 | 44 | 4 | 0 | 0 | 4 | 4 | 0 |
| Carter | 3 | 529 | 89 | 23 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cass | 35 | 418 | 366 | 21 | 14 | 2 | 0 | 2 | 0 | 0 |
| Cedar | 49 | 1045 | 1211 | 18 | 9 | 0 | 0 | 25 | 0 | 0 |
| Chariton | 56 | 1141 | 320 | 84 | 3 | 3 | 0 | 5 | 0 | 0 |
| Christian | 8 | 588 | 433 | 3 | 0 | 5 | 3 | 3 | 0 | 0 |
| Clark | 21 | 920 | 338 | 42 | 8 | 1 | 0 | 4 | 0 | 0 |
| Clay | 14 | 1041 | 458 | 93 | 13 | 5 | 0 | 7 | 0 | 0 |
| Clinton | 28 | 1336 | 385 | 142 | 6 | 6 | 0 | 3 | 0 | 0 |
| Cole | 25 | 592 | 333 | 32 | 2 | 8 | 4 | 4 | 0 | 0 |
| Cooper | 27 | 1230 | 435 | 80 | 23 | 0 | 2 | 8 | 0 | 0 |
| Crawford | 12 | 386 | 250 | 20 | 1 | 12 | 16 | 3 | 0 | 0 |
| Dade | 16 | 797 | 436 | 11 | 0 | 0 | 0 | 3 | 0 | 0 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Dallas | 31 | 649 | 932 | 7 | 4 | 2 | 0 | 4 | 0 | 0 |
| Davies | 29 | 864 | 380 | 169 | 2 | 10 | 0 | 0 | 0 | 0 |
| Dekalb | 15 | 838 | 475 | 73 | 2 | 6 | 0 | 2 | 2 | 0 |
| Dent | 5 | 555 | 656 | 13 | 2 | 0 | 1 | 8 | 0 | 0 |
| Douglas | 6 | 481 | 246 | 8 | 3 | 3 | 0 | 3 | 0 | 0 |
| Dunklin | 119 | 925 | 328 | 30 | 0 | 0 | 0 | 0 | 0 | 0 |
| Franklin | 9 | 467 | 383 | 17 | 3 | 3 | 1 | 4 | 0 | 0 |
| Gasconade | 13 | 1149 | 513 | 18 | 9 | 2 | 2 | 0 | 0 | 0 |
| Gentry | 29 | 732 | 328 | 107 | 29 | 11 | 0 | 11 | 0 | 0 |
| Greene | 12 | 687 | 519 | 16 | 18 | 1 | 0 | 6 | 0 | 0 |
| Grundy | 34 | 1051 | 34 | 0 | 34 | 0 | 0 | 0 | 0 | 0 |
| Harrison | 26 | 1448 | 462 | 26 | 8 | 0 | 0 | 10 | 2 | 0 |
| Henry | 27 | 1029 | 584 | 148 | 8 | 4 | 0 | 6 | 0 | 0 |
| Hickory | 8 | 1273 | 573 | 30 | 2 | 0 | 0 | 12 | 0 | 0 |
| Holt | 48 | 768 | 397 | 39 | 4 | 4 | 0 | 0 | 0 | 0 |
| Howard | 21 | 1008 | 478 | 52 | 10 | 1 | 0 | 4 | 0 | 0 |
| Howell | 9 | 789 | 332 | 20 | 3 | 0 | 0 | 15 | 0 | 0 |
| Iron | 0 | 375 | 0 | 83 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jackson | 18 | 860 | 249 | 77 | 11 | 6 | 0 | 6 | 0 | 0 |
| Jasper | 8 | 1022 | 251 | 48 | 10 | 3 | 0 | 15 | 0 | 0 |
| Jefferson | 28 | 598 | 351 | 27 | 5 | 5 | 0 | 3 | 0 | 0 |
| Johnson | 38 | 594 | 490 | 78 | 3 | 0 | 0 | 11 | 0 | 0 |
| Knox | 660 | 1396 | 660 | 52 | 7 | 1 | 0 | 4 | 1 | 0 |
| Laclede | 24 | 710 | 547 | 24 | 10 | 5 | 4 | 4 | 0 | 0 |
| Lafayette | 60 | 577 | 339 | 127 | 14 | 0 | 4 | 6 | 0 | 0 |
| Lawrence | 63 | 784 | 921 | 28 | 5 | 3 | 10 | 15 | 0 | 0 |
| Lewis | 24 | 873 | 350 | 65 | 12 | 4 | 0 | 5 | 0 | 0 |
| Lincoln | 10 | 560 | 492 | 20 | 5 | 3 | 0 | 3 | 0 | 0 |
| Linn | 40 | 1506 | 483 | 115 | 7 | 2 | 0 | 7 | 1 | 0 |
| Livingston | 31 | 1316 | 436 | 107 | 18 | 0 | 0 | 0 | 0 | 0 |
| McDonald | 23 | 436 | 41 | 0 | 8 | 0 | 0 | 8 | 0 | 0 |
| Macon | 21 | 1107 | 329 | 48 | 5 | 3 | 1 | 1 | 2 | 0 |
| Madison | 3 | 298 | 65 | 10 | 3 | 0 | 0 | 0 | 0 | 0 |
| Maries | 0 | 779 | 329 | 23 | 6 | 0 | 0 | 0 | 0 | 0 |
| Marion | 19 | 985 | 360 | 52 | 6 | 0 | 0 | 2 | 0 | 0 |
| Mercer | 7 | 1223 | 486 | 50 | 16 | 0 | 0 | 5 | 0 | 0 |
| Miller | 41 | 1079 | 288 | 53 | 24 | 4 | 4 | 0 | 0 | 0 |
| Mississippi | 0 | 296 | 370 | 0 | 37 | 0 | 0 | 0 | 0 | 0 |
| Moniteau | 47 | 1023 | 620 | 19 | 0 | 0 | 0 | 0 | 0 | 0 |
| Monroe | 23 | 585 | 523 | 30 | 9 | 1 | 0 | 0 | 0 | 0 |
| Montgomery | 31 | 866 | 301 | 18 | 6 | 0 | 3 | 3 | 1 | 0 |
| Morgan | 12 | 723 | 308 | 20 | 0 | 6 | 6 | 5 | 1 | 0 |
| New Madrid | 0 | 1143 | 0 | 0 | 143 | 0 | 0 | 0 | 0 | 0 |
| Newton | 83 | 785 | 234 | 15 | 10 | 7 | 7 | 7 | 0 | 0 |
| Nodaway | 60 | 1105 | 460 | 139 | 14 | 0 | 0 | 0 | 0 | 0 |
| Oregon | 9 | 981 | 354 | 0 | 0 | 0 | 2 | 6 | 0 | 0 |
| Osage | 14 | 862 | 604 | 51 | 7 | 3 | 0 | 6 | 0 | 0 |
| Ozark | 15 | 551 | 191 | 28 | 11 | 2 | 15 | 9 | 0 | 0 |
| Pemiscot | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Perry | 37 | 847 | 477 | 25 | 3 | 0 | 2 | 10 | 0 | 0 |
| Pettis | 19 | 1093 | 506 | 73 | 3 | 3 | 0 | 9 | 0 | 0 |
| Phelps | 52 | 723 | 695 | 27 | 6 | 1 | 5 | 6 | 0 | 0 |
| Pike | 28 | 1016 | 261 | 42 | 7 | 1 | 1 | 8 | 0 | 0 |
| Platte | 32 | 992 | 227 | 66 | 11 | 5 | 0 | 8 | 0 | 0 |
| Polk | 40 | 1150 | 893 | 38 | 15 | 1 | 0 | 7 | 0 | 0 |
| Pulaski | 8 | 551 | 282 | 19 | 2 | 0 | 2 | 2 | 0 | 0 |
| Putnam | 7 | 840 | 849 | 37 | 4 | 0 | 0 | 13 | 0 | 0 |
| Ralls | 26 | 1555 | 551 | 61 | 8 | 8 | 0 | 6 | 0 | 0 |
| Randolph | 22 | 797 | 497 | 35 | 12 | 2 | 0 | 14 | 1 | 0 |
| Ray | 51 | 1068 | 995 | 100 | 0 | 5 | 2 | 2 | 0 | 0 |
| Reynolds | 18 | 414 | 199 | 5 | 0 | 0 | 0 | 11 | 0 | 0 |
| Ripley | 10 | 604 | 131 | 19 | 3 | 0 | 0 | 6 | 0 | 0 |
| St Charles | 19 | 1018 | 424 | 18 | 4 | 2 | 2 | 2 | 0 | 0 |
| St Clair | 19 | 885 | 671 | 56 | 2 | 0 | 0 | 2 | 0 | 0 |
| St Francois | 23 | 567 | 360 | 4 | 2 | 72 | 6 | 6 | 0 | 0 |
| St Genevieve | 19 | 587 | 513 | 26 | 6 | 0 | 4 | 3 | 0 | 0 |
| St Louis | 23 | 1146 | 133 | 45 | 9 | 12 | 1 | 3 | 1 | 0 |
| Saline | 25 | 1424 | 333 | 124 | 10 | 0 | 0 | 10 | 0 | 0 |
| Schuyler | 21 | 683 | 516 | 32 | 3 | 35 | 21 | 0 | 0 | 0 |
| Scotland | 24 | 1260 | 410 | 80 | 3 | 0 | 3 | 6 | 0 | 0 |
| Scott | 0 | 3698 | 226 | 208 | 0 | 0 | 0 | 38 | 0 | 0 |
| Shannon | 12 | 375 | 220 | 4 | 0 | 0 | 0 | 8 | 0 | 0 |
| Shelby | 6 | 1076 | 204 | 75 | 3 | 0 | 0 | 0 | 0 | 0 |
| Stoddard | 2 | 614 | 67 | 194 | 30 | 0 | 0 | 4 | 0 | 0 |
| Stone | 21 | 467 | 162 | 0 | 0 | 0 | 0 | 6 | 0 | 0 |
| Sullivan | 26 | 1106 | 370 | 28 | 1 | 3 | 0 | 1 | 0 | 0 |
| Taney | 51 | 1053 | 381 | 9 | 0 | 7 | 0 | 2 | 0 | 0 |
| Texas | 15 | 571 | 343 | 7 | 0 | 2 | 0 | 6 | 0 | 0 |
| Vernon | 56 | 1367 | 406 | 70 | 11 | 0 | 0 | 9 | 2 | 0 |
| Warren | 12 | 412 | 103 | 13 | 2 | 7 | 0 | 3 | 0 | 0 |
| Washington | 11 | 293 | 551 | 39 | 2 | 0 | 4 | 7 | 0 | 0 |
| Wayne | 12 | 589 | 265 | 100 | 7 | 1 | 1 | 7 | 1 | 0 |
| Webster | 18 | 424 | 343 | 25 | 11 | 3 | 0 | 7 | 0 | 0 |
| Worth | 83 | 1853 | 621 | 147 | 54 | 0 | 0 | 10 | 5 | 0 |
| Wright | 12 | 946 | 423 | 0 | 6 | 3 | 0 | 15 | 0 | 0 |
| | | | | | | | | | | |
| State-wide Index | 24 | 877 | 424 | 46 | 7 | 4 | 1 | 5 | 0 | 0 |

# BADGER STATUS IN MISSOURI

**AN EXPLORATORY ASSESSMENT OF BADGER DEMOGRAPHICS AND CONSERVATION STATUS IN MISSOURI**

The badger is uncommon in Missouri and is considered a species of conservation concern. Its official rank is Unrankable (SU), however, as little data are available to form the basis for a ranking. MDC's current study is designed to collect badger observations and specimens from across the state. The information will be used to better understand the demographics and distribution of badgers in Missouri and to provide data from which to refine the status of badgers in Missouri.

The badger is a harvested species in Missouri, but harvest numbers have historically been low (generally fewer than 200 per year since the 1960s, and fewer than 100 per year since the 1990s). Arkansas ranks the species as S1 (Critically Imperiled), Ohio and Indiana as S2 (Imperiled), and Kansas as S3 (Vulnerable). Iowa ranks the badger as S4 (Apparently Secure), reflecting their apparent increased abundance in the grassland and open habitats that dominate the state. This habitat preference is also seen in Missouri, as the majority of harvested animals are from the northern portion of the state, and especially from northwestern Missouri.

Badger habitat has declined substantially in areas converted from grassland to intensive agriculture. Also, colonial rodents such as prairie dogs and ground squirrels (as in Missouri, where both Franklin's and thirteen-lined ground squirrels are also species of conservation concern) have been reduced or eliminated. Assessing the range and demographics of badgers in Missouri is hindered by a lack of information because 1) harvest data are insufficient to properly assess trends and 2) little baseline data are available on the biology and demographics of the species. MDC is using verified sightings from the public to define the minimum range of badgers in Missouri, to make initial and preliminary insights into the demographics of the Missouri population and to better refine the status of the species in MDC's heritage database.

Preliminary Results

From May 2010 through June 2011, MDC received 86 reports of badgers in Missouri from staff and the public, see Figure 1. From May 2010 through June 2011, 10 carcasses were collected from trappers and the public. Reproductive and age data will be determined by flushing uterine tracts and tooth cementum analysis, respectively.

From July 2011 to June 2012, MDC received an additional 26 badger reports from the public to bring the total observation reports to 273. MDC received four additional badger carcasses in 2012. Badger carcass collection decreased considerably in the past two years. MDC is no longer paying trappers for badger carcasses and currently are only receiving carcasses from MDC personnel and citizens interested in the study.

From July 2012 to June 2013, MDC received 44 badger reports from the public bringing our total observation reports to 317. Of those 44 reports, 18 accompanied a badger carcass, all but three of which have been necropsied. MDC is no longer paying trappers for badger carcasses; therefore, many of the specimens are collected road kills.

Physical data from badger carcasses collected in Missouri through June of 2013 show an average whole carcass weight of 16.7 lbs (n = 32) and an average length of 25 in (n = 30). Data for the carcasses that were received already skinned show an average weight of 13.2 lbs (n = 58) and a length of 23.6 in (n = 56). Each carcass collected had a tooth extracted and sent in for aging. A major portion of all badgers collected were less than 1-year-old (Figure 30).

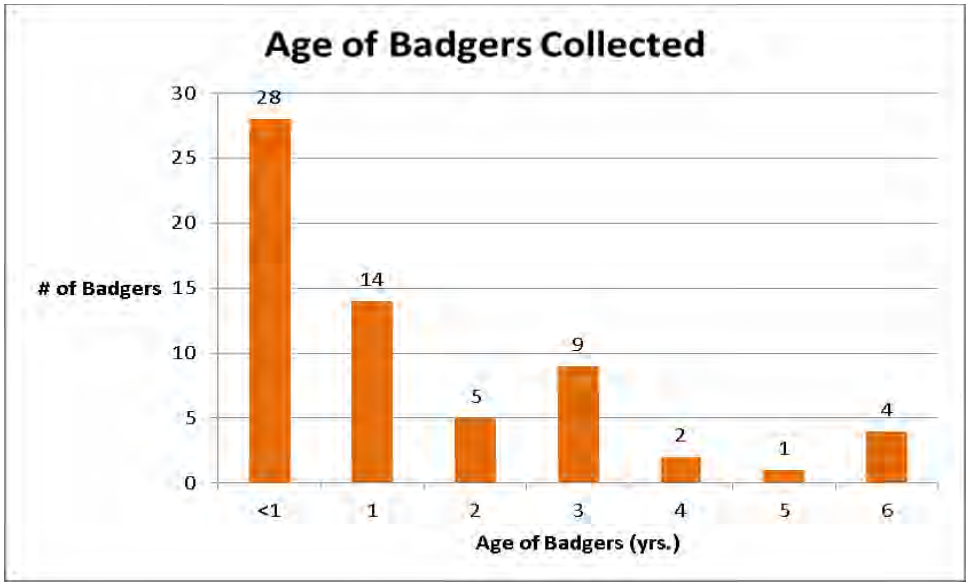



Figure 30. Age of badgers collected from 2010-3013

Data collected during this study were used to study the relationship between habitat and badger occurrence in Missouri. Badger observations were compared to land cover, elevation and soil type. Habitat characteristics associated with badger observations were then compared to habitat across the state. Results showed that 80 percent of observations occurred in grassland or cropland (Figure 32), 62 percent of observations occurred in alluvium and glacial drift soils (Figure 33) and 71 percent of observations occurred between 623 and 1016 feet elevation (Figure 34).

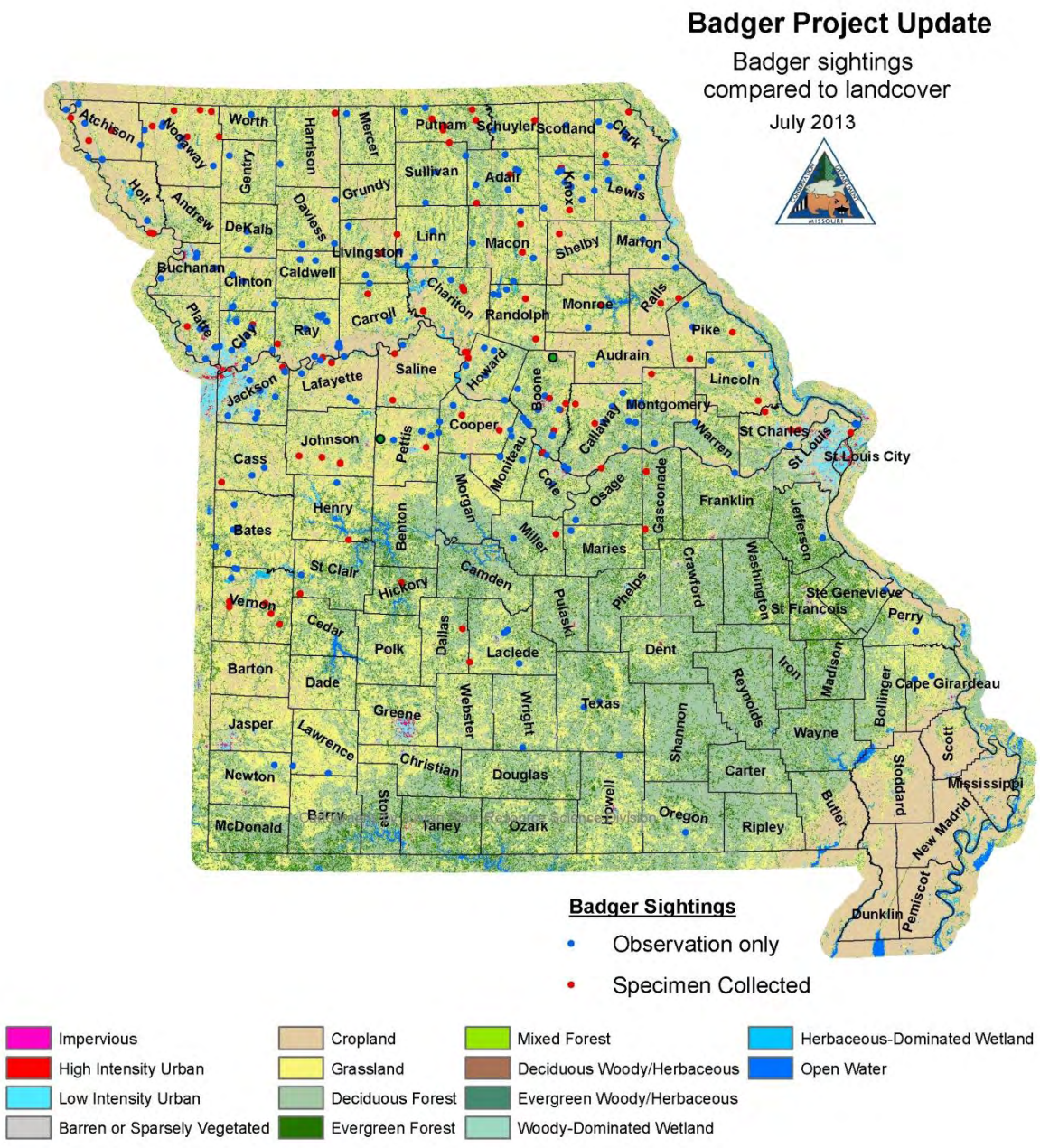



Figure 31. Badger locations based on reported sightings and carcass recoveries from trappers and road-killed animals.

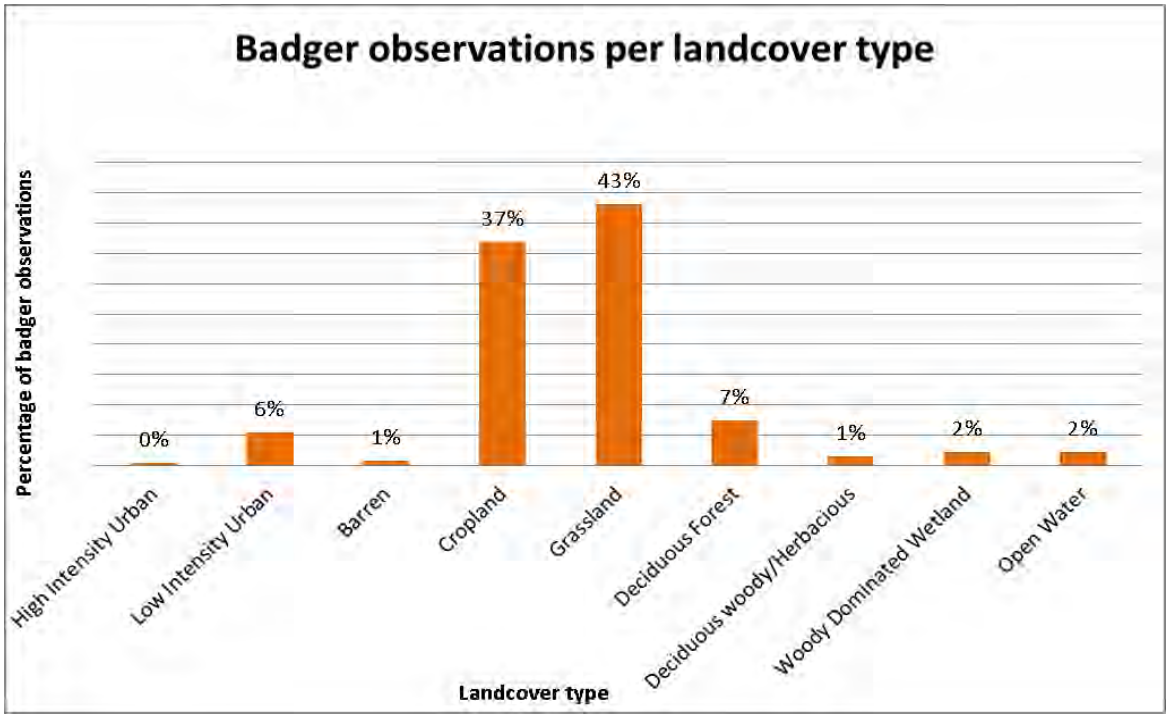



Figure 32. Percentage of badger observations per landcover type in Missouri.

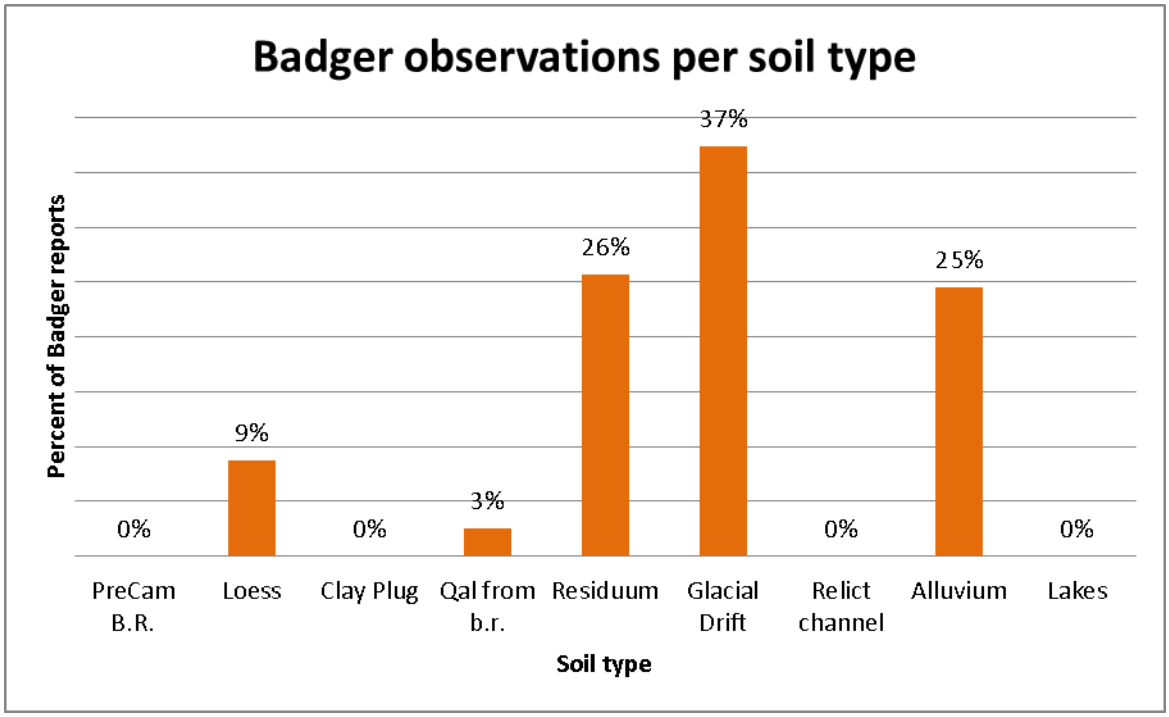



Figure 33. Percentage of badger observations per soil type in Missouri.

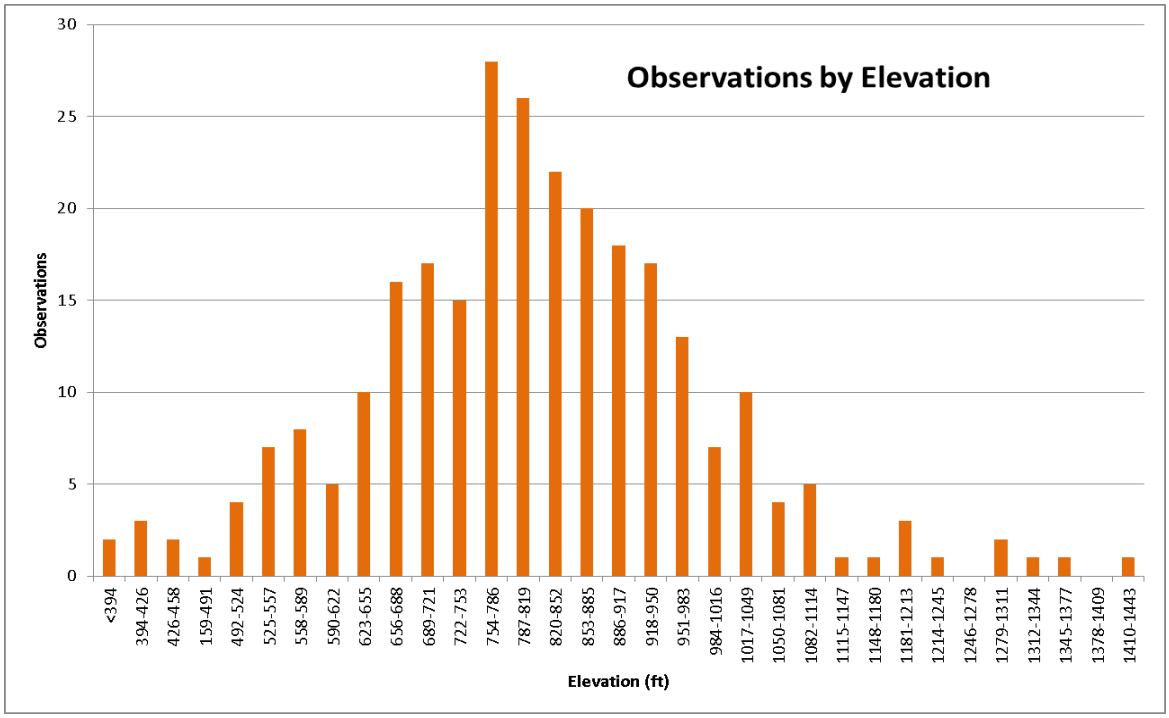



Figure 34. Badger observations compared to elevation in Missouri.

# MONITORING AND DEMOGRAPHIC ASSESSMENT OF RIVER OTTERS AND BOBCATS IN MISSOURI

Currently, Missouri has no harvest level restrictions on river otters or bobcats. Past harvest data suggest these species are not in danger of being overharvested. Harvest of these species has been challenged in a number of states because plaintiff's have alleged state agencies lacked sufficient data to allow harvest at current levels. The objective of this project is to collect age, sex and harvest effort data for otters and bobcats to be used for Statistical Population Reconstruction.

Research Implications and Benefits

Statistical Population Reconstruction provides a broad scale assessment whereas most other techniques are applicable to only local areas. MDC will have a better understanding of the relationship between harvest rates and demographics of each species. Population reconstruction will also provide the MDC with solid harvest and population data which will be more defensible if ever challenged in the court system. This format will be MDC's long-term monitoring plan. Harvest effort and information from these two species will be collected for five years (2010-2014).

Survey packets are sent to Missouri trappers at the beginning of each trapping season. These packets contain a monthly journal asking how many traps were set for both river otters and bobcats, how many nights each trap was set, and how many of each species were trapped. This will reveal the amount of trapping pressure these species undergo each year. Trappers are also being asked to remove one of the lower canine teeth from each otter and bobcat they harvest. From the teeth collected, the age of harvested animals can be determined. This is important information for a population model to determine if the population is increasing, decreasing or stable. Separate envelopes are included in this survey packet for this purpose. The survey, along with the teeth from each harvested animal, are placed in a postage-paid envelope and sent back to Resource Science Division.

Survey packets were sent to trappers at the end of October 2010 for the 2010-2011 trapping season. In total, 760 lower canine teeth were collected from both river otters and bobcats. The samples consisted of 370 teeth being from river otters and 390 being from bobcats. In the 2011-2012 trapping season a total of 828 samples were received with 59 samples being cut too short for analysis. The 769 samples sent in for aging consisted of 284 bobcat samples and 485 river otter samples. In the 2012-2013 trapping season a total of 1,241 samples were received with 161 samples being cut too short for analysis. The 1,080 samples sent in for aging consisted of 502 bobcat samples and 578 river otter samples. See figures 37 and 38 for initial age analysis of samples for the 2012-2013 season.

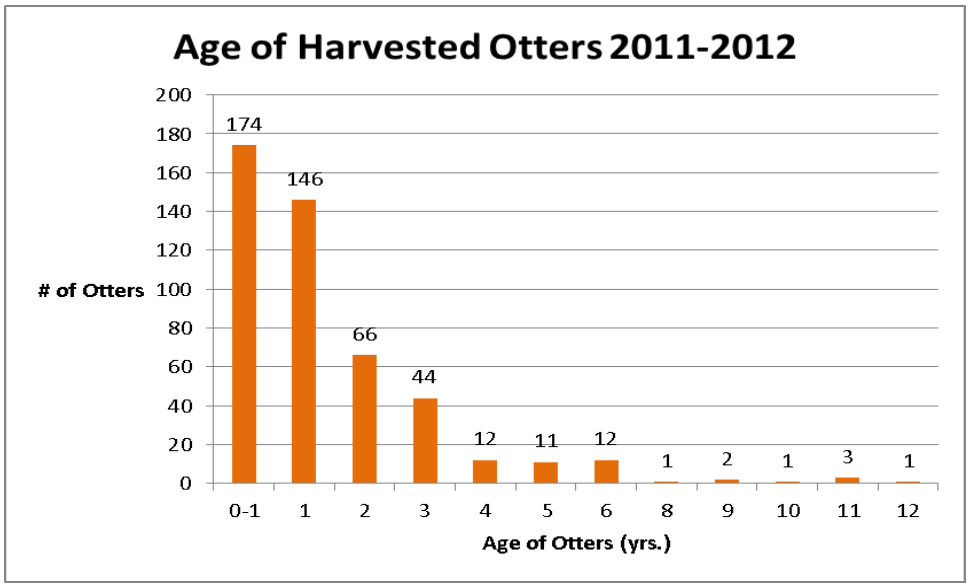



Figure 35. Age of otters sampled 2011-2012.

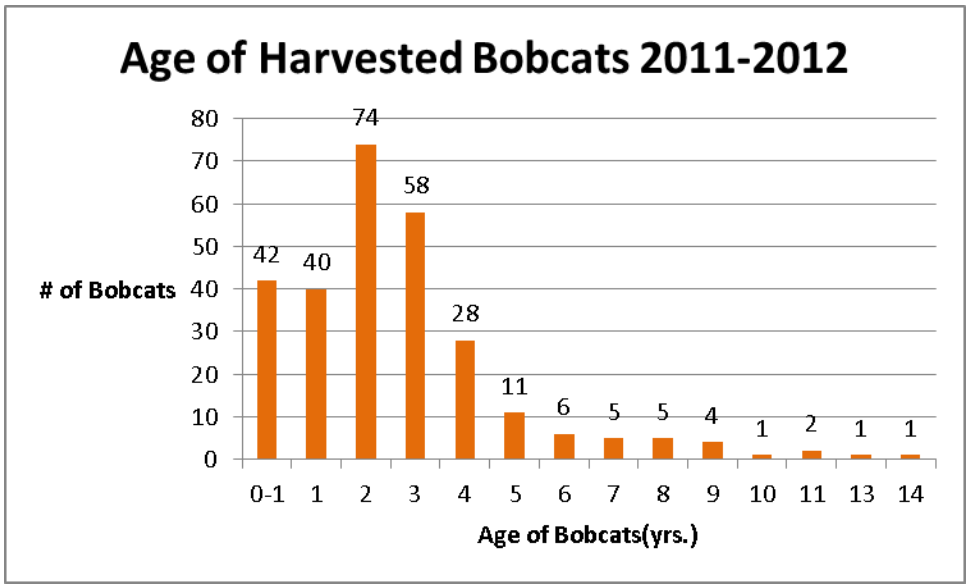



Figure 36. Age of bobcats sampled 2011-2012.

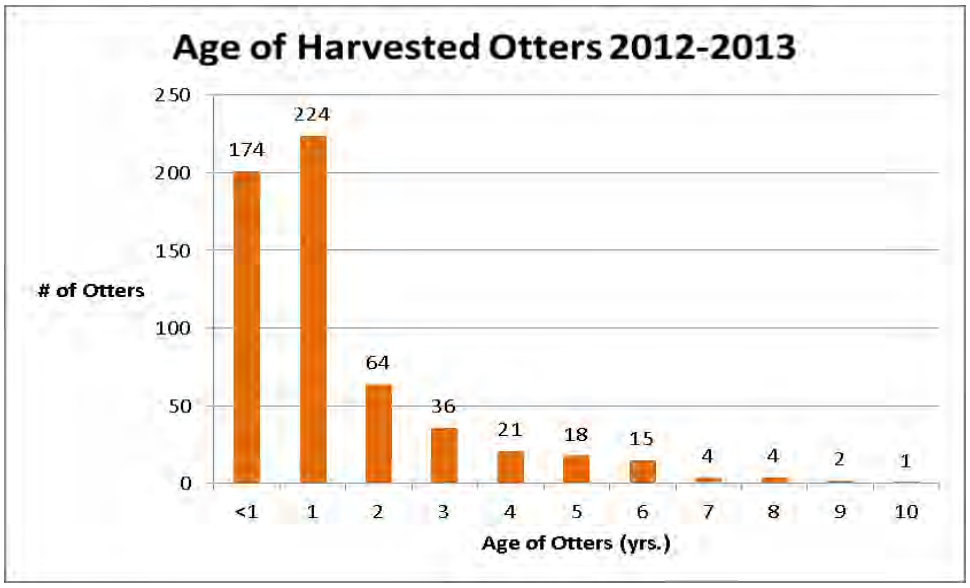



Figure 37. Age of otters sampled 2012-2013.

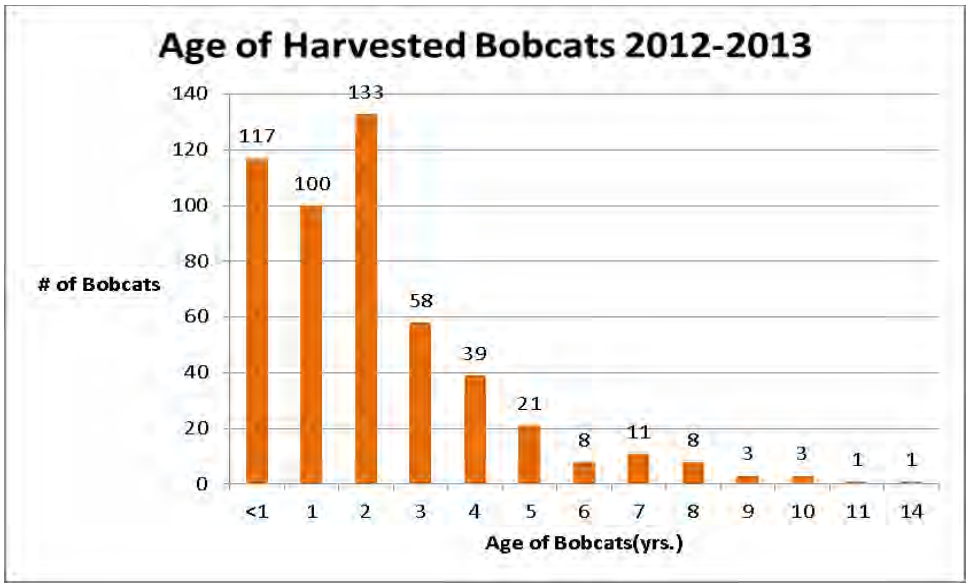



Figure 38. Age of bobcats sampled 2012-2013.

# LARGE CARNIVORE INVENTORY

**LARGE CARNIVORE INVENTORY AND MARKING STUDY:**

Background

Dangerous captive animals have recently come under public scrutiny. Because of the inherent danger and potential liability associated with the possession of large carnivores, an effective system was needed to verify ownership and better monitor the legitimate purchase, sale and trade of these animals. The Department of Agriculture is currently evaluating regulations for the possession of dangerous carnivores other than those regulated by MDC. The MDC has taken a proactive approach in response to the public demand for more accountability and to provide some consistency between us and the Department of Agriculture. The intent of these new provisions is to better enable our enforcement and record keeping obligations, safeguard permit holders from false claims of ownership, and satisfy public demand for higher accountability of these potentially dangerous animals. In addition, our Department will have the ability to distinguish captive animals from truly wild animals.

Based on these issues, MDC made significant regulation changes pertaining to large carnivores owned under the Class II Wildlife Breeder Permit. The proposal to permanently mark all captive bears, mountain lions, wolves and wolf hybrids was approved by the Regulations Committee and Conservation Commission in 2007. The regulation became effective March 1st, 2008 under code: 3 CSR 10-9.353 Privileges of Class I and Class II Wildlife Breeders and had a 1 July 2008 compliance date. Effective July 1, 2008, all mountain lions, black bears, wolves and wolf-hybrids held under the privileges of a Class II Wildlife Breeder Permit were required to be uniquely identified with a permanent Passive Integrated Transponder (PIT) microchip. These microchips are about the size of a grain of rice and contain an electromagnetic code that can be used to identify animals. They can be injected under the skin to permanently mark animals without altering external appearance. Microchips are normally placed just under the skin along the back of the animal, between the shoulder blades. This standardized protocol allows animals to be searched quickly and efficiently. The regulation also requires owners to allow the Department to obtain, from each animal, a small blood or tissue sample sufficient for DNA analysis.

Progress to Date

Surveys and interviews were completed for 33 of the then 50 captive carnivore owners in the state. Feedback from the interviews showed that a majority of owners are generally supportive of the new regulations, but have concerns about the welfare of their animals. An informational workshop was held in Jefferson City on February 9, 2008. The workshop provided a forum for MDC personnel, veterinarians and captive carnivore owners to discuss the procedures for marking captive animals. The contract with Wildlife Genetics International for DNA testing was finalized in May 2008, renewed in April 2009, 2010, and again in April 2011. DNA samples will be stored at Resource Science in Columbia until all samples have been collected and then will be sent to Wildlife Genetics International for analysis.

Department personnel have assisted in implanting microchips in and collecting DNA samples from 169 different animals at 46 facilities around the state. A total of 33 mountain lions, 27 black bears, 53 wolves and 56 wolf hybrids have been tagged. As of June 2013, all known owners of captive carnivores are in compliance with the regulation.

All permits to hold large carnivores expire June 30th of each year. Renewal letters and applications were sent to all current permit holders in April and May 2013. If the permits are not renewed by their expiration date, the permit holder is considered to be in violation of Missouri state code. Permit holders in violation may receive a citation from their local conservation agent if they wish to continue to hold large carnivores.

# MOUNTAIN LION RESPONSE TEAM

**MOUNTAIN LION RESPONSE TEAM**

The Missouri Department of Conservation developed a Mountain Lion Response Team (MLRT) in 1996 to address the concerns and reports from the public regarding mountain lions and the occasional confirmed occurrence of a mountain lion in the state. The MLRT consists of 12 employees across the state. MLRT members have special qualifications or have received training to address mountain lion concerns and conduct investigations when evidence is present.

Mountain lion sightings are categorized and entered into a long-term database. The MLRT also keeps track of confirmed cases of mountain lions in Missouri when there is hard, physical evidence to support a sighting such as a track, carcass, photo, video, etc. The MLRT has logged over 2,000 sightings in the database since 1994. There have been 41 mountain lion observations confirmed in the state (Table 10, Figure 39). Mountain lion confirmations continue to increase. Missouri has confirmed more mountain lion incidents than any other state without a known population. Lion confirmations in Missouri are the result of trail camera photos (75%), followed by DNA confirmation from hair, carcasses, and tracks. Genetic analysis from killed lions indicated origins of South Dakota, Montana and Colorado; all DNA-confirmed animals were males. Although the sex and origin from only 4 of our 41 confirmations has been documented, the information does help explain some of what is likely happening with lions in Missouri – that being that the majority of confirmed reports result from transient subadult males. Learning the sex and origins of some lions has enabled MDC to provide the public and media with timely updates about mountain lion occurrences, factual information about individual animals, and general information about their biology and habits.

Recent lion incidents in Missouri and Oklahoma suggest that some of these lions may not be transients and may be establishing home ranges, thus suggesting the presence of a female lion. There have been 16 sightings in a six- county region including Shannon, Texas, Oregon, Carter, Ripley and Reynolds counties. There have been 12 sightings confirmed by photos, two by hair samples, and one each of a carcass and a live capture. Six months after the first sightings, a mountain lion was killed in Texas County that was physically different than the mountain lions that had been previously caught on game camera. During the summers of 2011 and 2012, multiple Shannon county lion photos and kill sites were investigated over a course of six months; some of the photos were collected from the same location. Similarly, multiple lion photographs were collected over a six month period from a central Oklahoma location. This past winter a female lion was aerially gunned by USDA APHIS near the same Oklahoma area.

During this past year, over 264 reports of mountain lions were recorded in the state. This is a minimum number because many reports to local agency staff are not recorded. Most reports are the result of the MLRT website reporting form and email account. The MLRT confirmed 13 mountain lion sightings this past year.

Table 10. Confirmed Instances of Mountain Lions in Missouri.

| Date | Location | # | Description |
|---|---|---|---|
| 2013 August | Pulaski | 41 | Photo of mountain lion taken by motion-activated game camera |
| 2013 - February | Carter Co | 40 | Photo of mountain lion taken by motion-activated game camera |
| 2013 - January | Warren Co | 39 | Photo of mountain lion taken by motion-activated game camera |
| 2012 – December | Warren Co | 38 | Photo of mountain lion taken by motion-activated game camera (photo taken during the same time period as the other Warren county confirmation. Likely the same animal.) |
| 2012 - December | Carter Co | 37 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - December | Dekalb Co | 36 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - November | Taney Co | 35 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - October | Ripley Co | 34 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - October | Shannon Co | 33 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - September | Shannon Co | 32 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - September | Grundy Co | 31 | Photo of mountain lion taken by motion-activated game camera (Photo taken in April, near to and soon after previous Grundy county confirmation, not submitted until September.) |
| 2012 - September | Shannon Co | 30 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - April | Grundy Co | 29 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - February | Reynolds Co | 28 | Photo of mountain lion taken by motion-activated game camera |
| 2012 - January | Reynolds Co | 27 | Citizen captured live mountain lion in live trap. Mountain lion was tranquilized, measured, weighed and released. |
| 2011 - September | Gasconade Co | 26 | Citizen reported seeing mountain lion. Hair sample collected. DNA confirmed. |
| 2011 - September | Carter Co | 25 | Citizen reported seeing mountain lion. Hair sample collected. DNA confirmed. |

| | | | |
|---|---|---|---|
| 2011 - September | Reynolds Co | 24 | Photo of mountain lion taken by motion-activated game camera |
| 2011 - September | Wayne Co | 23 | MDC employee reported mountain lion tracks in roadway. MLRT investigation confirmed. |
| 2011 - September | Shannon Co | 22 | Photo of mountain lion taken by motion-activated game camera |
| 2011 - September | Texas Co | 21 | Sub adult male shot by landowner. No obvious signs of confinement. |
| 2011 - September | Shannon Co | 20 | Photo of mountain lion taken by motion-activated game camera |
| 2011 - August | Oregon Co | 19 | Photo of mountain lion hindquarters taken by motion-activated game camera |
| 2011 - August | Shannon Co | 18 | Photo of probably sub-adult disperser taken by motion-activated game camera |
| 2011 - April | Macon Co | 17 | Citizen reported mountain lion tracks in creek bed. MLRT investigation confirmed. |
| 2011 – March | Oregon Co | 16 | Citizen reported observing a cat jump a fence. DNA analysis of hairs collected at the scene confirmed species, ancestry analysis underway. |
| 2011 – February | Linn Co | 15 | Photo of probably sub-adult disperser taken by motion-activated game camera |
| 2011 – January | Macon Co | 14 | Sub-adult male shot by coyote hunters. No obvious signs of confinement. DNA analysis indicated probable South Dakotan ancestry. |
| 2011 – January | St Louis Co | 13 | Photo of probable sub-adult disperser taken by motion-activated game camera. |
| 2010 – December | Ray Co | 12 | Sub-adult male shot by raccoon hunter. No obvious signs of confinement.<br>DNA analysis indicated probable South Dakotan ancestry. |
| 2010 – November | Platte Co | 11 | Photo of probable sub-adult disperser taken by landowner.<br>DNA analysis of hairs collected at the scene could not confirm ancestry. |
| 2006 – December | Livingston Co | 10 | Photo of probable sub-adult disperser taken by motion-activated game camera. |
| 2006 – November | Shannon Co | 9 | Deer carcass characteristic of mountain lion kill with tracks found nearby. |
| 2003 – August | Callaway Co | 8 | Approximately 1½-year-old male road kill. No obvious signs of confinement. |
| 2002 – October | Clay Co | 7 | Two-to-three-year-old male road kill. No obvious signs of confinement. |
| 2001 – December | Pulaski Co | 6 | Photo of probable sub-adult disperser taken by motion-activated game camera. |

| | | | |
|---|---|---|---|
| 2000 – December | Lewis Co | 5 | Video by deer hunter in a tree stand. |
| 1999 – January | Texas Co | 4 | Animal treed by rabbit hunters' dogs. Tracks in snow, and two deer carcasses characteristic of mountain lion kills found nearby. |
| 1997 – January | Christian Co | 3 | Video by property owner (obtained through Dr. Lynn Robbins at Missouri State University in Springfield). Animal's behavior suggested possible former captive. |
| 1996 – November | Reynolds Co | 2 | Night-time video by Conservation Agent of cat on deer carcass. |
| 1994 – December | Carter Co | 1 | Small adult female treed and shot (through the eye with a .22) by two raccoon hunters near Peck Ranch Conservation Area. Carcass was never recovered, but obtained photo of animal on truck tailgate. Federal authorities fined each hunter $ 2,000.<br>In November 1998 a deer hunter found the skinned pelt of a small adult female with head and feet attached by a remote Texas County road. Pelt showed signs of freezer burn, and x-ray of skull revealed bullet fragments. Although likely the same animal, it cannot be confirmed. |

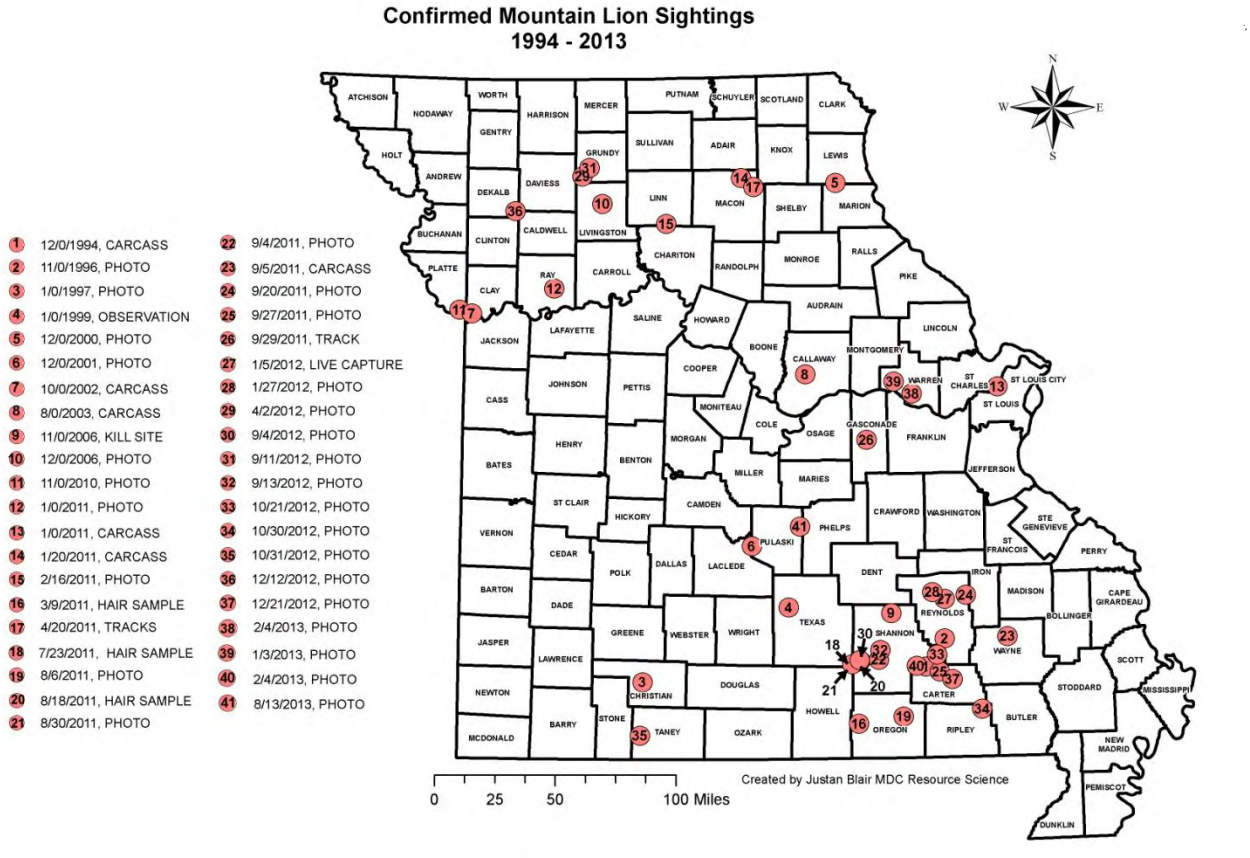



Figure 39. Confirmed locations and information for mountain lions in Missouri from 1994-2013.

# BLACK BEAR DISTRIBUTION AND STATUS

**Summary**

MDC completed a new management plan for black bears in Missouri in 2008. The plan was drafted and approved by a multi-agency group of resource professionals from the Missouri Department of Conservation, U.S. Forest Service, National Park Service and Missouri Department of Natural Resources during summer of 2008 and was signed and approved by MDC administration during fall of 2008.

**Black bear goal/vision statement:**
To encourage black bear population expansion within their natural range in Missouri, and to manage black bears consistent with the available habitat and within the limits of human tolerance.

**Black bear program objectives:**

- Increase knowledge about current black bear population status in Missouri.
- Increase knowledge of black bear ecology in Missouri, how they move, disperse and travel on a landscape level and identify source and sink populations.
- Develop black bear conservation and management strategies based on information gathered through research, monitoring and surveys.
- Educate Missouri's public, the media and other resource professionals in Missouri and the Midwest about black bears and Missouri's black bear management program.


The entire black bear management plan can be viewed on SharePoint at:
http://mdcsharepoint/sites/resourcescience/Documents/Terrestrial%20Fauna/Furbearers/Black%20Bear%20Management%20Plan%20November%2025%202008.pdf.

**Black bear research – population estimation**

American black bears (*Ursus americanus*) are an important wildlife resource in Missouri, yet little information is known about their population status. Black bears were believed to be extirpated from Missouri by the early 1900s due to overharvest and deforestation; however, they have been naturally recolonizing and increasing in abundance in southern areas of the state since the 1960s. Increased abundance has resulted in more interest in black bears as well as nuisance complaints and safety concerns from the public. The Missouri Department of Conservation (MDC) is encouraging range expansion of black bears while managing the species consistent with available habitat and within limits of human tolerance. MDC's intent is to conduct research that will increase knowledge of black bear ecology critical for developing conservation and management strategies. The objectives of this project are to:

1. Develop synthesis of history, status and management of black bears in Missouri;
2. Quantify occurrence and magnitude of heterogeneity in capture probabilities, and
3. Estimate abundance and density of black bears in Missouri.

In a recently recovering population of black bears, such as in Missouri, establishing an accurate and robust baseline population estimate is critical for developing a reliable long-term conservation plan. The estimated population size derived from this overall study will influence decisions to implement a bear hunting season in the state. Understanding the sources of heterogeneity in Capture Mark Recapture studies is essential for producing sound population estimates to manage Missouri's black bear population.

**Study Area**

The study area was derived from the 70 percent fixed kernel isopleth applied to black bear sightings (1989-2010) and comprises 29,775 $km^2$ in southern Missouri (Figure 40). The area was divided into two regions to be surveyed in different years: the south-central region in 2011 (13,508 $km^2$) and the southeastern/east-central region in 2012 (16,267 $km^2$). Land ownership is private and public, including Mark Twain National Forest and Ozark National Scenic Riverways. Predominant land covers include cropland (30.9%), pastureland (24.3%) and forest land (27.8%); (National Resources Inventory 2000). Forest cover in southern Missouri is dominated by oak-hickory (*Quercus alba, Quercus velutina, Quercus coccinea, Quercus rubra, Carya spp.*) and oak-pine (*Pinus echinata*) upland type forests (Missouri Department of Conservation 2011). Southern regions are rugged and mountainous with elevations ranging from 70-540 m (United States Geological Survey 2009). The Ozark Mountains are characterized by exposed formations of sandstone, chert, dolomite, limestone and igneous rocks (Batek et al. 2001). Southern Missouri (Climate Division 4 and 5) temperatures average 23.8°C (June-July 1989-2010) and precipitation (June-July 1989-2010) averages 218 mm (National Climatic Data Center 2011).

**Methods**

**Physical capture and marking of black bears**

Black bears are captured during September-October and May-August using Aldrich foot snares and cage traps. Captured bears are immobilized with 7 mg/kg tiletamine-zolazepam administered using a $CO_2$-powered rifle or syringe pole. Temperature, heart rate and respiration are monitored every 10 minutes during immobilization for at least 20 minutes post-induction. Morphometric measurements and body weight is recorded for each individual and an upper premolar tooth extracted for cementum aging analysis. Minor wounds caused by capture are treated with Betadine. Male and female bears are ear tagged and fitted with GPS collars (Northstar NSG-LD2, RASSL Globalstar, King George, Virginia, USA) programmed to collect locations every 10 minutes from 30 May to 28 July and one location per day thereafter. In order to maximize detail of bear movements during hair snare sampling sessions, locations were automatically downloaded every 10 minutes directly to an online database (Northstar Science and Technology, LLC) and illustrated using GIS. Tables 11 and 12 lists capture data since the projects inception.

**Hair trapping experimental design**

Table 11. Capture data for Missouri black bear project 2010-2013

| Capture Data 2010-2013 | | | |
|---|---|---|---|
| Total Captures to Date | 101 | Total Males with Collars | 32 |
| Total Bears Fitted with Collars | 53 | Total Female Captures* | 38 |
| Total Male Captures* | 59 | Total Females with Collars | 21 |

*Gender of one cub of year not listed

Table 12. Missouri black bear project capture by county 2010-2013

| County | Number of Captures | | County | Number of Captures |
|---|---|---|---|---|
| ** | 1 | | Reynolds | 1 |
| Barry | 1 | | Shannon | 18 |
| Carter | 1 | | Taney | 1 |
| Christian | 6 | | Texas | 1 |
| Douglas | 17 | | Webster | 22 |
| Howell | 17 | | Wright | 1 |
| Oregon | 12 | | Total | 103 |
| Ozark | 4 | | | |

Black bear hair samples were collected using double-stranded barbed-wire hair detectors. Detectors were constructed using 4-barbed, 15.5 gauge wire to create an enclosure around 3 or more trees, with each strand about 20 cm and 50 cm above ground. Raspberry oil (Mother Murphy's Laboratories, Inc., Greensboro, NC), anise oil (Minnesota Trapline Products, Pennock, MN), and Ultimate Bear Lure (Wildlife Research Center, Ramsey, MN) were applied on perimeter trees forming the enclosure, about 2 m above ground. Decaying logs were placed in the center of the enclosure and saturated with 0.5 L of fish oil as an attractant. Hair detector stations were re-lured every 10 days at the beginning of each consecutive sampling occasion. Hair samples were collected at the end of each sampling occasion. All hair found on a barb or single tree was considered one sample. Samples were placed in separate paper envelopes, labeled, and air dried before processing. Each barb was flamed to prevent contamination across occasions (Figure 43, Figure 44).

During the initial year a broad scale approach was used to detect and define areas with reproducing populations (Figure 41). During the second year 403 hair detectors were established in 5, 210 $km^2$ sampling arrays (A–E) with 2.6 $km^2$ cells in south-central Missouri (Figure 42). One hair detector was allocated to each cell and monitored over 6, 10 day intervals from 04 June 2012 to 08 August 2012. Hair detector locations were selected based on habitat characteristics and availability of forested private and public land. GIS was used to select approximate locations for hair detectors using forest cover data (30m resolution, Missouri Spatial Data Information Service 2005) as initial criteria to maximize bear detection; excluding open water, agricultural, and developed areas.
Final hair detector locations were placed within about 300 m of initial locations and out of sight from human trails or dwellings. Additionally, recent bear activity, habitat, and topographic features were used to select hair detector locations to maximize black bear capture. Oversampling of detector locations was conducted in the event existing land use or ownership precluded detector placement.
DNA-based encounter history data was used from each hair detector array and spatially-explicit capture-recapture (SECR) models to estimate black bear density in southern Missouri. Data was analyzed using package 'secr' in program R. 14 a priori models were developed with varying effects on the parameters of

density (D) and detection ($g_0$, σ). The parameter $g_0$ is the probability of detection at the activity center of an individual and σ is the spatial scale of movement. Effects on $g_0$ and σ included time factor (t), learned response (b), transient response (B), site learned response (k), 2-class finite mixture for heterogeneity (h2), and sex (g). Habitat masks were generated for each array to define the outer limit of integration for the SECR model and to exclude areas of non-habitat (eg, water, roads, urban, agriculture) from fitted models. Mask area for each array was used to derive estimated population size (*E(N)*) from density estimates.

***Detection Biases***

DNA data collected from hair traps was compared using 2 sampling designs tested in southern Missouri during 2011 and 2012 and compared parameter estimates using capture-recapture models. Movement patterns of GPS-collared bears and remote camera images were also assessed to estimate detection bias. In 2011, we used an array (29,775 $km^2$) with 100 $km^2$ cells and allocated 378 traps proportionate to number of historical bear sightings per cell (Fig. 36). In 2012, 403 traps were established in 5, 210 $km^2$ sampling arrays with 2.6 $km^2$ cells, each containing one trap (Fig. 37).

We established 100 motion-sensitive infrared triggered cameras (Cuddeback Attack IR, Green Bay, Wisconsin, USA) each year at hair detectors in estimated home ranges of GPS-collared black bears. One camera was placed per hair detector with each camera mounted 1–2 m above ground on a tree 5–10 m away from a hair detector to capture the entire detector and immediate surroundings. All cameras recorded 1 still image and 1, 30 second video per activation every 1 minute and recorded date and time. Images were downloaded at the end of each sampling occasion about 380 hair snare stations per year (1 snare/38.6 $km^2$ in 2011, 1 snare/46.5 $km^2$ in 2012).

Table 13. Model selection results for top ranked fitted model ranked by AICc to estimate American black bear density (D) for 2011 and 2012 sampling designs.

| Year and top model | Density (bears/$km^2$) | SE.D | CI.D | Mask Area ($km^2$) | *R(N)* | SE.N | CI.N | $g_0$ | SE.$g_0$ | σ (km) | SE.σ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2011 | | | | | | | | | | | |
| 1. D~1, g0~bk, sigma~1 | 0.007 | 0.002 | 0.004–0.012 | 12,948 | 57 | 12 | 41–92 | 0.003 | 0.001 | 14,879 | 3,093 |
| 2012 | | | | | | | | | | | |
| 1. D~1, g0~bk, sigma~1 | 0.02 | 0.005 | 0.02–0.04 | 10,105 | 171 | 22 | 138–227 | 0.009 | 0.001 | 8,839 | 1,002 |

**Conclusion**

Black bear density in southern Missouri appears heterogeneous and isolated to areas of contiguous forest (e.g., Mark Twain National Forest). Density of bears within the area of integration at each array varied greatly. This illustrates the importance of sampling from multiple arrays in different regions of potentially occupied black bear habitat for obtaining reliable estimates, particularly in regions where presumed habitat may be isolated by large areas of unsuitable landcover (i.e., agriculture, pastureland). Spatially explicit models offer advantages over traditional non-spatial models by allowing use of more complex covariate models, providing density estimates with greater precision. Modeling movements and sex-specific space use is important for wide-ranging and sexually dimorphic species such as black bears, where extent of spatial sampling design is typically constrained by available resources and logistics. Differences between 2011 and 2012 detector sampling designs appeared to greatly increase black bear capture success in 2012. Results suggest trap spacing and density, as well as heterogeneity in bear behavior, are important for estimating detection parameters with high precision. Increasing trap density increased number of detectors available per black bear home range, thereby increasing probability of detection and reducing the potential of missing individuals within the sampling array. Accounting for detection biases is challenging, but an important consideration when developing monitoring programs and

management strategies. Based on hair snare data and analysis our point estimate for black bears in Missouri is 252 bears(Table 13).

**Sundries**

Field sampling for obtaining black bear density and abundance estimates using hair detectors was completed in August 2012. Manuscripts for black bear density and detection biases are currently being prepared for publication. Our manuscript *American black bear distribution and human-bear conflicts in Missouri* is currently in review at *The American Midland Naturalist.*

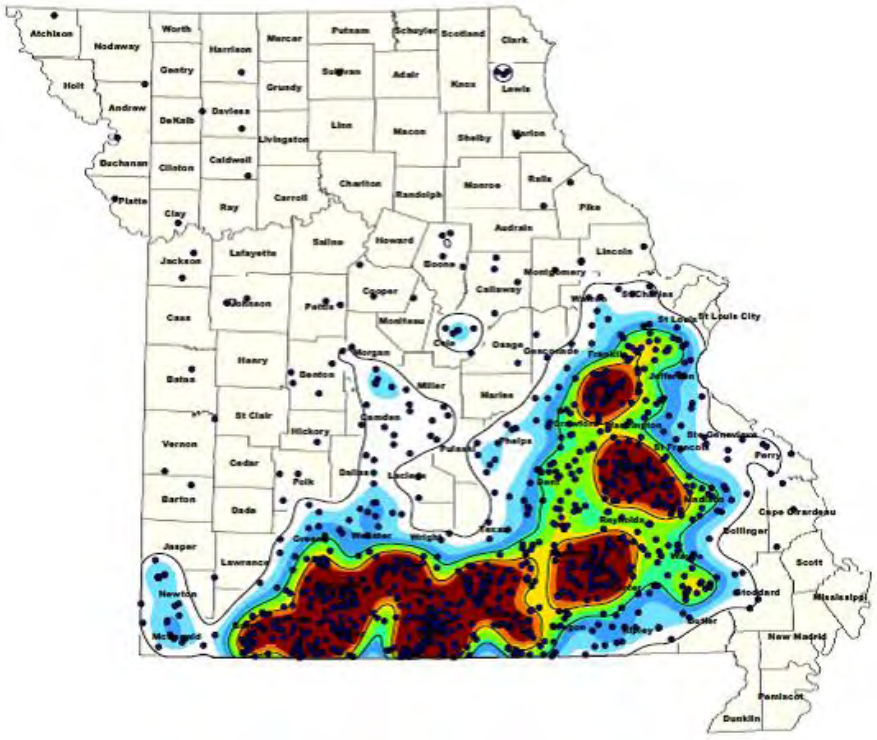



Figure 40. Kernel density estimation of black bear sightings (1989 – 2010) with 70% isopleth highlighted in light blue.

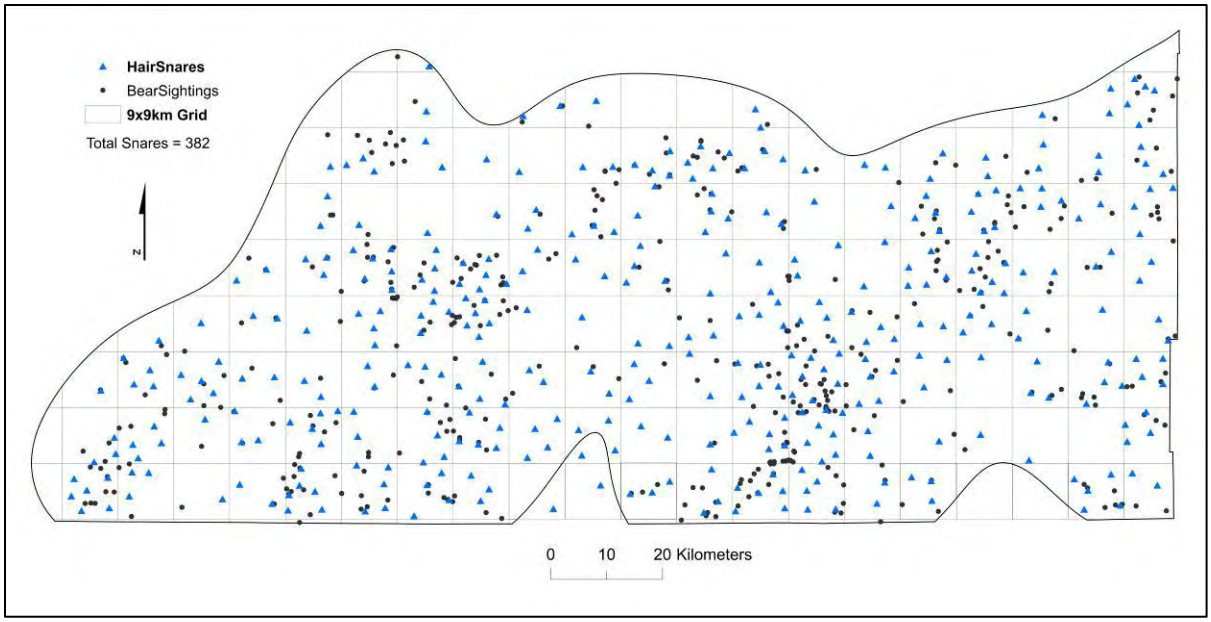



Figure 41. Distribution of hair snares and black bear sightings (1989-2010) for 2011 survey area, southcentral Missouri.

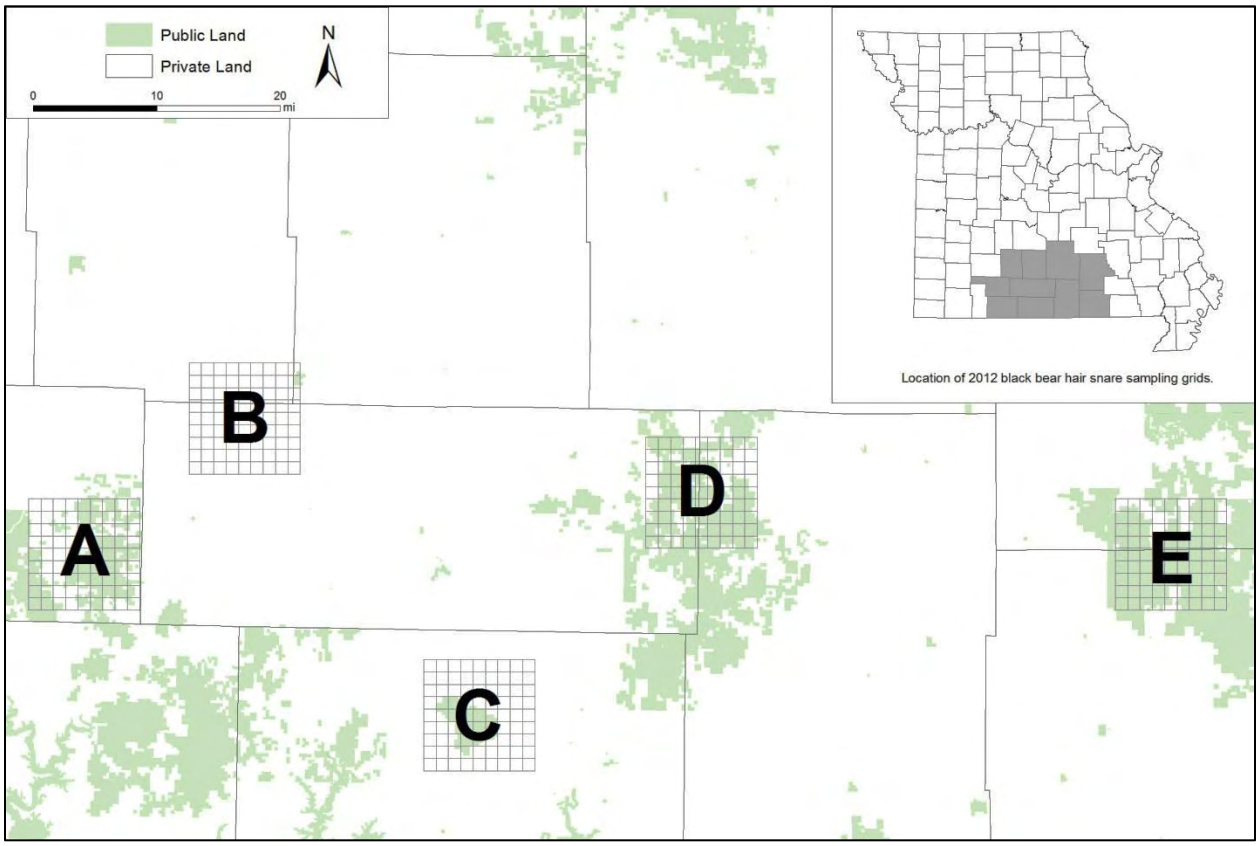



Figure 42. Location of 2012 black bear hair detector sampling arrays (A–E) in south-central Missouri.

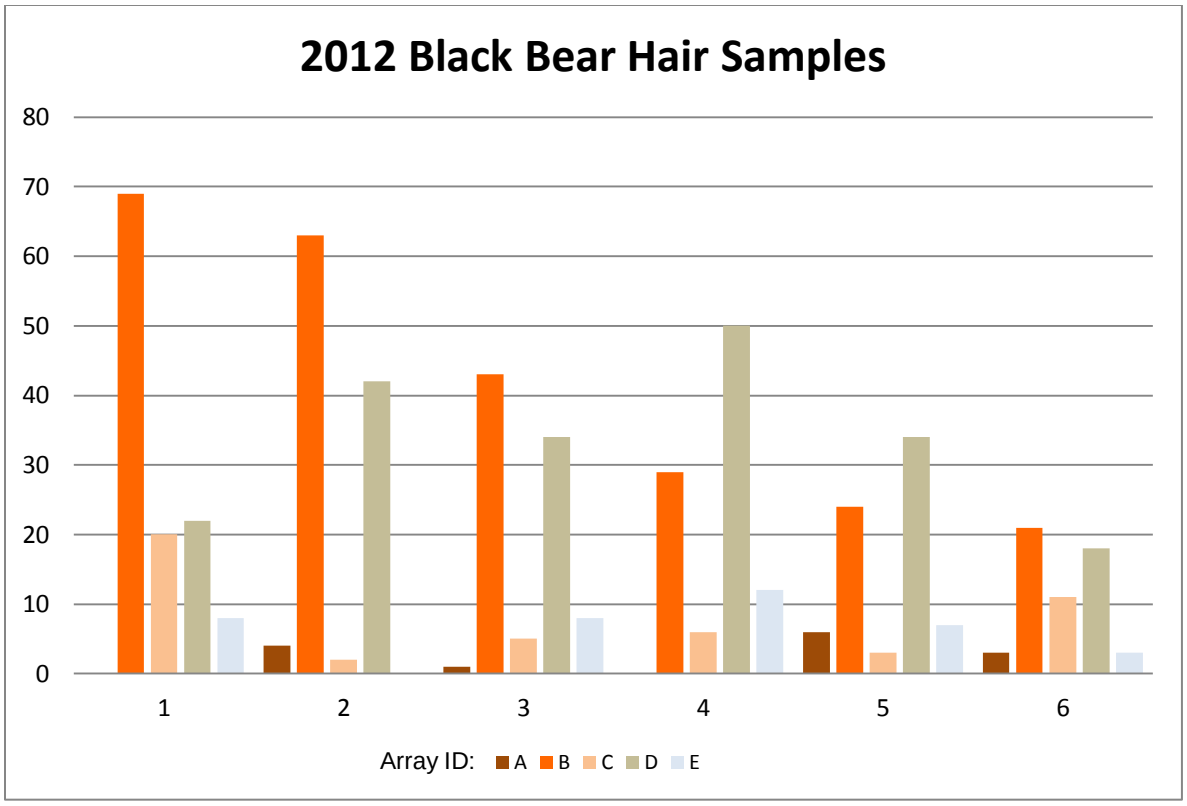



Figure 43. Number of black bear hair samples collected in each sampling array per occasion.

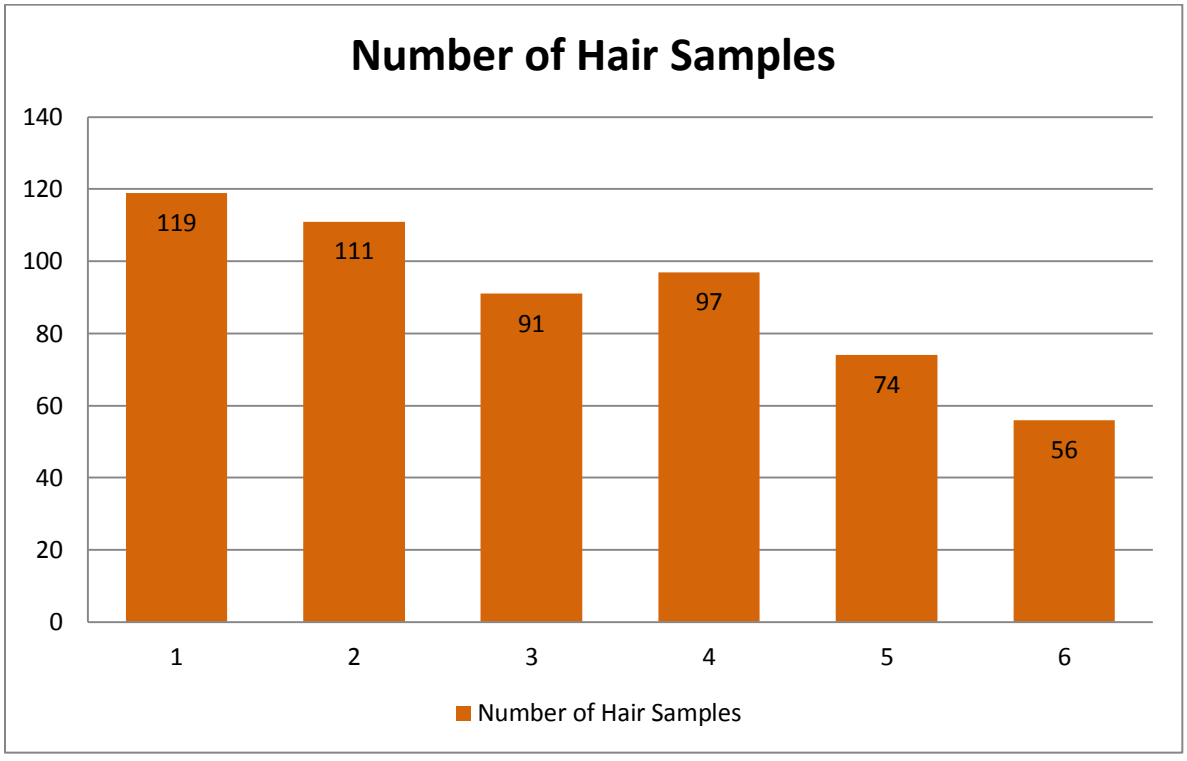



Figure 44. Total number of black bear hair samples collected in each sampling occasion.

**Acknowledgements**

We thank the many MDC personnel that assisted with private lands access, hair snare construction, prebaiting and trapping, and various logistical matters. Funding sources included MDC, Federal Aid in Wildlife Restoration, Safari Club International Foundation and Mississippi State University.

Our current research proposal designed to quantify black bear numbers and sex ratios in parts of southern Missouri can be viewed on SharePoint at: http://mdcsharepoint/sites/resourcescience/Documents/Division%20Administration/Programs%20and%20Projects/FY11%20Projects/One%20Page%20Proposals/Bearpopest_FY11%20One%20Pager.docx.